STAFF REPORT

SUPPLY AND COST OF ALTERNATIVES TO MTBE IN GASOLINE

TECHNICAL APPENDICES

External CARB Gasoline Supply

DECEMBER 1998

CALIFORNIA ENERGY COMMISSION

STATE OF CALIFORNIA ENERGY COMMISSION

Pete Wilson, *Governor*

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EXTERNAL CARB GASOLINE SUPPLY

Prepared For:

ACUREX ENVIRONMENTAL CORPORATION
AND
CALIFORNIA ENERGY COMMISSION

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1. INTRODUCTION

1.1 PARTIES

Purvin & Gertz, Inc., (Purvin & Gertz), was retained by Acurex Environmental Corporation (Acurex) on behalf of the California Energy Commission (CEC) to provide evaluations and assistance related to the proposed MTBE ban in California. Purvin & Gertz was retained to provide four deliverables: a presentation at a public workshop, a report on the supply costs of CARB gasoline and blend stocks from outside California, a report on the marine terminal infrastructure and associated limitations, and compilation of the final report combining Purvin & Gertz work with that of other consultants. This document is the report describing the supply costs of CARB gasoline and blend stocks from outside California.

This report has been prepared for the sole benefit of the CEC. Any third party in possession of the report may not rely upon its conclusions without the written consent of Purvin & Gertz.

Purvin & Gertz conducted this analysis and prepared this report utilizing reasonable care and skill in applying methods of analysis consistent with normal industry practice. All results are based on information available at the time of review. Changes in factors upon which the review is based could affect the results. Forecasts are inherently uncertain because of events or combinations of events which cannot reasonably be foreseen including the actions of government, individuals, third parties and competitors. ***NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY.***

Some of the information on which this report is based has been provided by others. Purvin & Gertz has utilized such information without verification unless specifically noted otherwise. Purvin & Gertz accepts no liability for errors or inaccuracies in information provided by others.

Two other consultants, Mathpro, Inc. (Mathpro) and Energy Security Analysis, Inc. (ESAI) are preparing parallel reports on other aspects of the MTBE ban under separate contracts with Acurex. Although the goals of the work are joint, the three consultants, Purvin & Gertz, Mathpro and ESAI, are working independently and none is responsible for the work or results of another. Neither Mathpro nor ESAI is responsible for any results presented in this report.

1.2 PURPOSE AND BACKGROUND

There are legislative proposals in California which would ban or restrict the use of MTBE as a gasoline blending component. MTBE is widely used in California as part of refiners' efforts to comply with reformulated gasoline requirements imposed by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB). The California legislature has determined that prior to considering a ban or restriction on the use of MTBE as a gasoline component, CEC should study possible impacts on the supply and cost of gasoline in California.

Three contractors were selected to participate with CEC in the study. Mathpro was chosen to prepare linear program (LP) models of the California refining industry. These models were to be used by Mathpro to estimate the capabilities of the refineries to produce CARB gasoline under a variety of scenarios and to estimate the capital and operating changes that would occur in the event that MTBE is banned or restricted under a variety of scenarios. ESAI was retained to identify the supply costs of various oxygenate materials as alternatives to MTBE. The results of this report by Purvin & Gertz would be combined with results from ESAI by Mathpro as part of its LP analysis of the California refining industry. Purvin & Gertz was chosen to combine the results determined by Mathpro and ESAI into a final report for CEC reflecting the opinions of each of the individual consultants. The scope of this study is limited to costs of external supplies of CARBOB. Price impacts on other markets, the adequacy of marine infrastructure costs to manufacture CARBOB within the state, oxygenate supply and cost issues and price impacts to the consumer are covered in separate documents.

Policy recommendations regarding the path which should be followed with respect to the MTBE ban or restriction are to be made by CEC. Purvin & Gertz makes no recommendation in this report whether any particular policy option is superior to another. The scopes of the reports of the consultants are confined to expert opinions of cost and supply impacts. CEC is responsible for making any policy recommendations after giving appropriate consideration to the reports of the consultants as well as to other information as may be deemed appropriate by CEC.

1.3 SCENARIOS AND ASSUMPTIONS

The CEC effort encompasses many alternative cases so that each logical oxygenate is reviewed and important legislative/regulatory alternatives are considered.

All of the cases evaluated in this study involve preparation of a CARB gasoline blend stock in the distant location that could be shipped to California for further blending with the selected oxygenate. This oxygenate-free material is referred to as “CARBOB”. The CARBOB would be combined with the oxygenate material, ethanol, ETBE, TAME, or TBA, after arrival in California. In our analysis we considered the quality of the final blend of the CARBOB and the oxygenate to assure that the mixture would meet CARB gasoline specifications.

The CEC study includes effects of both a California-only MTBE ban as well as a nationwide MTBE ban. The range of cases considered is as shown below:

Oxygenate	Regulatory Change
Ethanol	None
Ethanol	1 PSI RVP Waiver
ETBE	None
TBA	None
Mixed Oxygenates	None
None	HR 630

The underlying assumption in all the cases is that MTBE would be banned. There is no assumption of a mandate to use any specific oxygenate in any case. The oxygenate alternatives were evaluated individually for purposes of clearly identifying costs and not as a suggestion that banning MTBE implies a mandate to use any particular oxygenate in its place.

Ethanol was evaluated in two ways. First, ethanol was evaluated using all existing regulations. Second, ethanol was evaluated in the context of a one psi waiver of the Reid Vapor Pressure (RVP) specification provided ethanol is blended at 10% by volume.

Three other oxygenate cases were considered: ETBE, TBA and mixed oxygenates. It was considered likely that adequate ETBE or TBA capacity could be developed to allow these materials to be produced to satisfy California requirements at some reasonable cost. The mixed oxygenate case is based on an open mixture of materials including TBA, ETBE, TAME and DIPE. The supplies of TAME or DIPE alone were thought not to be likely to be adequate to meet all of California’s requirements in any reasonable case and therefore these oxygenates were evaluated together with others on a mixed basis.

Finally, a case was evaluated in which no oxygenate at all was required. Since federal laws and regulations as well as state laws and regulations govern the oxygen content of a large fraction of California’s gasoline, modifications to federally-imposed requirements would need to be made as a precondition to producing California’s gasoline supply as anticipated by this case.

There may be air quality and other costs or benefits associated with one oxygenate or another or one or more of the regulatory modifications reflected in these cases. This study does not purport to evaluate any of those costs or benefits. The scope of the study is limited to identifying sources and costs of accessing supplies of fuels of various types.

2. SUMMARY

2.1 METHODOLOGY

The methodology used to determine CARBOB supply curves is based on relating CARBOB producibility in each of seven regions of the world to characteristics of the more suitable refineries in that region. Refineries were evaluated using a “CARB Index” which measures the presence of the types of refinery process equipment that are commonly found useful for making CARB gasoline. Only those refineries with the highest probability of making commercial quantities of CARBOB were evaluated further.

CARBOB production volume was established based on evaluating recombinations of existing refinery gasoline streams rather than on fundamental reorientations of refinery operations. The least expensive way for refineries to produce a new product typically would be to select suitable materials from those already produced and simply blend the new product using different recipes than those that had been used in the past. Some volume of CARBOB can be produced in this way. A higher cost method would be to select different crude oils for the refinery that were more suitable to the new product or to alter refinery operating practices to produce more of the new product. An even more costly and time consuming procedure would be to make capital improvements at the refinery that would improve the ability of the refinery to transform any given crude oil into the new product. This last and most extreme method would usually be justified only if a large volume of the product were to be required, more than could be accomplished by the first two methods, if the requirement were to be long term or if the product is particularly valuable so the cost of the capital could be recovered. In this report, only the first type of procedure is considered. In using this method, only the least expensive increments of production were identified. In the event that this volume were inadequate to meet the need, then more expensive and extreme steps would have to be anticipated but as this report will show, these less expensive steps were adequate to identify reasonable volumes of supply.

For the CARBOB-Capable group in each region, an estimate was made of the amount of alkylate that could be diverted to manufacturing CARBOB. Alkylate is a relatively costly refinery product that can be used to produce high value premium gasolines and aviation fuels. Refiners would be unwilling to release all of their alkylate production because of other high value uses.

Based on typical gasoline blend stock qualities for each region and the requirements of the predictive model, the amount of CARBOB that could be blended from a given volume of alkylate was estimated. Combining these ratios with the amount of alkylate that is estimated to be available resulted in the volume of CARBOB that could be produced in each region.

The cost of producing CARBOB from each region of the world was based on a buildup of costs by type. Based on historical summer 1997 data, the prevailing gasoline price in each region of the world was established. The opportunity costs of producing some gasoline to CARBOB required specifications and an allowance for ancillary costs were estimated. The costs to ship the product to California including time value of holding inventory, direct shipping costs, and terminaling charges in California were estimated. Provision was made for refiner incentive over and above cost recovery.

Combining the cost and volume data for each region of the world resulted in a supply cost curve for CARBOB. The results vary depending on some of the scenarios used. There is inevitable uncertainty associated with determining supply curves in this manner that results from future regulatory changes in supply areas, commercial factors related to contracting for CARBOB supplies, fluctuations in refinery operations and other factors. The risk that supply would actually be available increases at higher supply levels.

2.2 REFINING CAPACITY

There are approximately 730 refineries with about 76 million barrels per day of capacity in the world outside California. These refineries produce about 17 million barrels per day of gasoline. These refineries were grouped by region and each region was segregated into two classes: those refineries with configuration characteristics consistent with some possibility of manufacturing commercial quantities of CARBOB and those lacking those characteristics. Table 2.2-1 summarizes the results of these analyses.

TABLE 2.2-1
REFINERY CAPACITY
(Barrels per Stream Day)

	Total		CARB Capable		CARB Incapable	
	Refineries	Capacity	Refineries	Capacity	Refineries	Capacity
Pacific North West	5	575,350	1	108,200	4	467,150
U.S. Gulf Coast (USGC)	56	7,005,515	29	6,027,350	27	978,165
Caribbean	14	1,733,900	2	865,000	12	868,900
Europe	108	14,374,735	19	3,742,850	89	10,631,885
Latin America	66	5,796,143	5	1,457,325	61	4,338,818
Middle East	46	5,756,290	2	580,600	44	5,175,690
Far East	176	17,707,312	16	4,094,236	160	13,613,076
Other	255	23,037,723	42	7,136,388	213	15,901,335
TOTAL	**726**	**75,986,968**	**116**	**24,011,949**	**610**	**51,975,019**

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2.3 ALKYLATE AVAILABILITY

Some of the alkylate produced by CARBOB-Capable refineries could be made available for blending CARBOB. Not all the alkylate from these refineries could be made available because of other requirements for alkylate. Alkylate is an important component of EPA-reformulated gasoline produced on the U.S. Gulf Coast (USGC) and is a component of high-value premium gasolines as well as aviation gasolines produced in all regions of the world.

Alkylate availability is not influenced by the selection of which oxygenate is assumed to be used in California. The influence of oxygenate selection is confined to the gasoline blending which can occur using the released alkylate. Hence there are only two cases for alkylate supply, a California-only MTBE ban and the nation-wide MTBE ban.

Based on discussions held with refiners and consideration of the other requirements for alkylate, a set of alkylate availabilities was prepared.

Table 2.3-1 shows the total amount of alkylate estimated to be available from each region of the world.

TABLE 2.3-1
ALKYLATE AVAILABILITY
(Barrels per Stream Day)

	Alkylate Capacity	Alkylate Availability California MTBE Ban	Alkylate Availability Nationwide MTBE Ban
Pacific North West	12,000	4,000	4,000
U.S. Gulf Coast	503,000	86,000	43,000
Caribbean	22,000	11,000	11,000
Europe	158,000	27,000	27,000
Latin America	84,000	25,000	25,000
Middle East	27,000	8,000	8,000
Far East	85,000	14,000	14,000
TOTAL	**891,000**	**175,000**	**132,000**

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In most parts of the world, the availability of alkylate is not directly influenced by whether an MTBE ban is imposed in California only or on a nation-wide basis in the U.S. It has been assumed that there is no ban in other countries in either case. In the Pacific North West, an MTBE ban would not be expected to affect summertime alkylate supplies. Only in the USGC there would be a significant influence on alkylate supplies because of a relative octane shortfall that could accompany a nation-wide ban.

As with most refinery intermediates and blendstocks, there is little trade in alkylate. Consequently, while it is considered reasonable that refiners should be able to release such quantities of alkylate as shown in Table 2.3-1, there is greater probability with respect to neat alkylate than there is with finished CARBOB that refiners would be reluctant to release these volumes in regular practice. Hence, these volumes will be used directly to calculate CARBOB availabilities but it would be prudent to limit expectations for purchased alkylate to a lower value of 100,000 barrels per day in the California only ban cases and 75,000 barrels per day in the nation-wide MTBE ban cases.

2.4 CARBOB/ALKYLATE RATIOS

Manufacturing CARBOB involves blending with alkylate other refinery gasoline streams of varying qualities. The combination of these streams must, when mixed with the oxygenate, meet CARB gasoline specifications. CARB specifications may be met by any of three methods: flat limits, averaging limits, or predictive model. The predictive model is the most flexible method and tends to maximize supplies of CARB gasoline from any set of blend stocks. The ability of external refineries to produce CARBOB from alkylate was evaluated in light of the predictive model.

All the CARB specification alternatives involve evaluating many gasoline properties that are not well-reported around the world. Furthermore, there is some danger of over-optimizing the gasoline blending. In light of the quality of the available data as well as to reduce the danger of over-optimization, refinery regions were assigned to CARBOB/Alkylate ratio classes.

The CARBOB/Alkylate ratio representative of each class was evaluated by using the predictive model and typical gasoline blend stock qualities. Under normal circumstances at least one to two barrels of other blend stocks could be combined with one barrel of alkylate and meet CARBOB requirements. If refineries have reasonable levels of control of benzene and sulfur in blend stocks, then blending two to three barrels of other blend stocks with one barrel of alkylate is quite reasonable. If refineries have superior control of contaminants then perhaps four to six barrels of other blend stocks can be combined with one barrel of alkylate. The California refiners as a group operate in this upper range. Table 2.4-1 shows the CARBOB/Alkylate ratios used for each class.

TABLE 2.4-1
CARBOB/ALKYLATE RATIO CLASSES

Low	2.5
Medium	3.5
High	5.5

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Each region and case was evaluated to determine the appropriate CARBOB/Alkylate class. Table 2.4-2 shows the matrix of cases and classes that were used.

TABLE 2.4-2
CARBOB/ALKYLATE RATIO CLASS ASSIGNMENTS

	Ethanol No Waiver	Ethanol Waiver	TBA	ETBE	Mixed Oxygenates	No Oxygenate
Pacific North West	Low	Low	Medium	Medium	Medium	Low
U.S. Gulf Coast	Low	Low	High	High	High	Low
Caribbean	Low	Low	Low	Low	Low	Low
Europe	Low	Low	High	High	High	Low
Latin America	Low	Low	Low	Low	Low	Low
Middle East	Low	Low	Low	Low	Low	Low
Far East	Low	Low	Low	Low	Low	Low

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Reviewing Table 2.4-2 shows that the number of different solutions is not as large as the number of cases. Blending ethanol with no RVP waiver or with a waiver but at the 10% level imposes restrictions on refiners that often lead to appreciably less CARBOB availability. The same difficulty is encountered in the no oxygenate case. The CARBOB/Alkylate ratio classes are the same whether the refiners are blending TAME, ETBE, TBA, or mixed oxygenates. There would still be some difference in CARB gasoline supply due to variations in the amount of oxygenate required to be blended with the CARBOB.

2.5 COSTS OF SUPPLY

Supply costs were estimated starting with the prevailing price of gasoline in each market in the summer of 1997. The prevailing price of gasoline in each market as represented by the spot price is viewed as the alternative value of the blend stocks diverted to CARBOB production. A cost element for direct processing costs was added. This cost is reflective mostly of the opportunity to blend low cost butane with gasoline which is lost due to the lower vapor pressure required to meet CARB specifications. A provision of 0.5 cents per gallon of CARBOB was made for incidental direct costs such as costs to clear tankage, extra laboratory testing, any extra energy costs that might be related to more severe debutanization and the like. Octane credit is a negative cost element which captures the unusually low octane to which CARBOB can be produced. The oxygenate with which CARBOB is blended provides several octane numbers in most cases. A provision was made for the extra costs to hold inventory including the time value of money incurred during shipping and any cargo consolidation costs at the port of origin. Transportation costs were determined based on Worldscale quotes for appropriately sized tankers on international voyages and industry data for domestic voyages. A provision was made for terminaling costs in California of 0.75 cents per gallon of CARBOB. A refiner margin of two cents per gallon was added to reflect the need for reasonable profit to induce refiners in distant locations to undertake the effort of making CARBOB.

None of these cost elements are sensitive to which oxygenate is under consideration except for the processing costs and the octane credit. Processing cost varies because the vapor pressure of the oxygenates is different. Likewise the amount of octane credit available depends on which oxygenate is used. Because the cost of only CARBOB and not finished CARB gasoline is being determined, the cost figures are not sensitive to oxygenate costs.

There is some risk that delivering large volumes of CARBOB, alkylate, or other products to California and that shipping large volumes of non-CARB gasoline or intermediates away from California might disrupt typically observed ship availabilities or costs. Since such trade would be a very small fraction of international clean products movements, such risk for international origins or destinations is considered small. Domestic shipments would need to be moved using Jones Act carriers, the supply of which is much smaller. In the long term, it would be possible, if appropriate contracts for use were in place, to build new Jones Act carriers, or possibly even to reconfigure the domestic pipeline system to accommodate some shipments. In the intermediate term, there would not be adequate time to build new tankers and a Jones Act carrier shortfall could influence CARBOB or alkylate supply patterns. In the event of a shortage of carriers, less efficient and more costly foreign sources might be preferred.

2.6 SUPPLY CURVES

Table 2.6-1 shows the CARBOB supply curve for the California only MTBE ban. Each increment of supply represents the supply from a region at the cost associated with that region. The volume available from various sources is dependent on the availability of the alkylate and the CARBOB/Alkylate ratio assigned to that region.

Table 2.6-2 shows the CARBOB supply curve for the nation-wide MTBE ban case. The principal difference in these cases is the lowered availability from the USGC which occurs because more Gulf Coast alkylate must be retained to meet challenges of an MTBE ban east of the Rockies.

For reference, the average summertime 1997 spot price of CARB reformulated gasoline is estimated to have been 63.7 cents per gallon. The historical CARB reformulated gasoline price is not comparable to the CARBOB prices because the CARBOB must in most cases be blended with an oxygenate to produce CARB reformulated gasoline. The costs of that blending are not in this study.

TABLE 2.6-3
EXTERNAL ALKYLATE SUPPLIES
CALIFORNIA ONLY MTBE BAN

Region	Cost ¢/Gal	Volumes, B/D Region	Cumulative
Europe	77.0	27,000	27,000
Caribbean	78.4	11,000	38,000
Latin America	78.1	25,000	63,000
Pacific North West	79.7	4,000	67,000
Far East	81.4	14,000	81,000
U.S. Gulf Coast	81.5	86,000	167,000
Middle East	82.1	8,000	175,000

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Table 2.6-3 shows the alkylate supply curve for all cases involving a California-only MTBE ban. To the extent that alkylate is delivered to California, there is less alkylate available to manufacture CARBOB in the exporting region. Table 2.6-4 shows the alkylate supply curve for all cases involving the nation-wide MTBE ban.

TABLE 2.6-4
EXTERNAL ALKYLATE SUPPLIES
US WIDE MTBE BAN

Region	Cost ¢/Gal	Volumes, B/D Region	Cumulative
Europe	77.0	27,000	27,000
Caribbean	78.4	11,000	38,000
Latin America	78.1	25,000	63,000
Pacific North West	79.7	4,000	67,000
Far East	81.4	14,000	81,000
U.S. Gulf Coast	81.5	43,000	124,000
Middle East	82.1	8,000	132,000

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Uncertainty is associated with the alkylate availability for the same reasons as for the CARBOB as discussed above. Furthermore, trade in refinery intermediates is considered to carry more supply risk than trade in finished products and competing buyers for available supplies may exist or develop. Consequently, notwithstanding that the supply curves extend to the values shown in Table 2.3-1, it is recommended that limits of 100,000 barrels per day for the California only MTBE ban and 75,000 barrels per day for the U.S.-wide MTBE ban be adopted for refinery modeling purposes.

TABLE 2.6-1
SUPPLY CURVE
EXTERNAL CARBOB SUPPLIES - CALIFORNIA ONLY MTBE BAN

		Ethanol (No Waiver)	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.7	67,000	67,000
Latin America	68.8	63,000	130,000
Caribbean	69.3	26,000	156,000
U.S. Gulf Coast	72.5	214,000	370,000
Pacific North West	72.9	10,000	380,000
Middle East	73.0	21,000	401,000
Far East	73.7	34,000	435,000

		Ethanol (Waiver)	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.2	67,000	67,000
Latin America	67.4	63,000	130,000
Caribbean	67.8	26,000	156,000
U.S. Gulf Coast	71.0	214,000	370,000
Pacific North West	71.2	10,000	380,000
Middle East	71.5	21,000	401,000
Far East	72.5	34,000	435,000

		Mixed Oxygenates	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.5	148,000	148,000
Latin America	67.8	63,000	211,000
Caribbean	68.2	26,000	237,000
U.S. Gulf Coast	71.3	470,000	707,000
Pacific North West	71.6	14,000	721,000
Middle East	71.9	21,000	742,000
Far East	72.8	34,000	776,000

		TBA	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.2	148,000	148,000
Latin America	68.4	63,000	211,000
Caribbean	68.9	26,000	237,000
U.S. Gulf Coast	72.0	470,000	707,000
Pacific North West	72.3	14,000	721,000
Middle East	72.6	21,000	742,000
Far East	73.5	34,000	776,000

		ETBE	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	66.8	148,000	148,000
Latin America	67.1	63,000	211,000
Caribbean	67.4	26,000	237,000
U.S. Gulf Coast	70.6	470,000	707,000
Pacific North West	70.6	14,000	721,000
Middle East	71.1	21,000	742,000
Far East	72.0	34,000	776,000

		No Oxygenates	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.8	67,000	67,000
Latin America	69.0	63,000	130,000
Caribbean	69.4	26,000	156,000
U.S. Gulf Coast	72.6	214,000	370,000
Pacific North West	72.8	10,000	380,000
Far East	73.0	34,000	414,000
Middle East	73.1	21,000	435,000

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TABLE 2.6-2
SUPPLY CURVE
EXTERNAL CARBOB SUPPLIES - US WIDE MTBE BAN

Ethanol (No Waiver)

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	68.7	67,000	67,000
Latin America	68.8	63,000	130,000
Caribbean	69.3	26,000	156,000
U.S. Gulf Coast	72.5	107,000	263,000
Pacific North West	72.9	10,000	273,000
Middle East	73.0	21,000	294,000
Far East	73.7	34,000	328,000

Ethanol (Waiver)

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	67.2	67,000	67,000
Latin America	67.4	63,000	130,000
Caribbean	67.8	26,000	156,000
Pacific North West	71.0	10,000	166,000
U.S. Gulf Coast	71.2	107,000	273,000
Middle East	71.5	21,000	294,000
Far East	72.5	34,000	328,000

Mixed Oxygenates

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	67.5	148,000	148,000
Latin America	67.8	63,000	211,000
Caribbean	68.2	26,000	237,000
Pacific North West	71.3	14,000	251,000
U.S. Gulf Coast	71.6	235,000	486,000
Middle East	71.9	21,000	507,000
Far East	72.8	34,000	541,000

TBA

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	68.2	148,000	148,000
Latin America	68.4	63,000	211,000
Caribbean	68.9	26,000	237,000
U.S. Gulf Coast	72.0	235,000	472,000
Pacific North West	72.3	14,000	486,000
Middle East	72.6	21,000	507,000
Far East	73.5	34,000	541,000

ETBE

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	66.8	148,000	148,000
Latin America	67.1	63,000	211,000
Caribbean	67.4	26,000	237,000
Pacific North West	70.6	14,000	251,000
U.S. Gulf Coast	70.6	235,000	486,000
Middle East	71.1	21,000	507,000
Far East	72.0	34,000	541,000

No Oxygenates

Region	Cost ¢/Gal	Volumes, B/D Region	Volumes, B/D Cumulative
Europe	68.8	67,000	67,000
Latin America	69.0	63,000	130,000
Caribbean	69.4	26,000	156,000
Far East	72.6	34,000	190,000
Pacific North West	72.8	10,000	200,000
Middle East	73.0	21,000	221,000
U.S. Gulf Coast	73.1	107,000	328,000

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3. METHODOLOGY

This section presents the basic methodology that was used to estimate supply costs for CARBOB from outside California. The goal of this study is to evaluate the supply curve for CARBOB to California. Based on preliminary work prepared by CEC as well as comments by refining industry representatives, it is anticipated that in many cases California refineries could find the ability to meet CARB specifications reduced without MTBE. Since California consumes about 900,000 barrels per day of gasoline and part of that fuel is expected to be supplied by the California refineries, the external supply range of greatest interest is zero to several hundred thousand barrels per day.

There are about 750 refineries in the world with a total capacity of about 78 million barrels per day. The world's refineries vary extremely widely in feed stocks, operating goals, level of process sophistication and prevailing product specifications. Some refineries are simple topping plants that do little more than separate components naturally occurring in local crude oils into products. Such plants either do not produce gasoline or use tetra-ethyl lead or similar compounds to produce gasoline. The gasoline produced might be of very low octane, unsuitable for modern high-performance engines such as those found in the California automotive fleet. Most of the other refineries that produce gasoline rely primarily on processes like reforming that produce gasolines similar to those found in the U.S. twenty years ago. A few refineries are very highly sophisticated producing high quality products similar to CARB gasoline from a variety of crude oil types. Most of the refineries in the world are expected to be irrelevant to external CARBOB supplies and only a fraction of the world refineries will contribute to such supplies.

California's gasoline requirements are very small compared to world petroleum markets. The world's refineries produce about 17 million barrels per day of gasoline and total products of about 70 million barrels per day. The supply volume of interest to this study is perhaps one to three percent of total world gasoline output or substantially below one percent of total world refined products output.

Opportunistic blending is the most likely method to be used for producing external CARBOB supplies. In the event that MTBE is banned in California and refineries outside the state are called on to supply CARBOB to the state, it is considered unlikely that distant refineries would make substantial investments to provide the fuel or reorient their operations toward supplying the distant market. Historically the U.S. West Coast has been a geographically isolated and fairly self-sufficient market accepting only small volumes of imports. From a real-world perspective, it is more likely that refineries already possessing useful blend stocks in reasonable volumes would either produce the fuel from those available blend stocks or would sell blend stocks to intermediaries who would aggregate such stocks from various refiners into commercial scale cargoes meeting applicable specifications.

The very small proportion of total refined products output that would be desired for California indicates that a refinery modeling technique relying on aggregations of large numbers of refineries would be unreliable for evaluating supply costs. Such techniques would be subject to over-optimization for which no practical and reliable correction has been identified. Because of the large number of refineries it was impractical to model each refinery or even small groups of refineries. Finally, because the real world response to the possible supply problems posed by an MTBE ban is more likely to be one of opportunistic blending rather than fundamental shifts in refinery operations, approaches to supply cost estimation based on shifts in operations are considered to be impractical.

The technique chosen to resolve the problem is based on estimating the opportunity cost of diverting high quality blend stocks to producing CARBOB for California rather than conventional products for local markets. To the opportunity cost of the blend stocks, estimates of identifiable additional direct costs as well as refiner incentive have been added. Differences among opportunity costs from different areas of the world result from different prevailing prices in those areas. Direct cost differences can arise from transportation cost differences and other similar factors. The major steps in the analysis are outlined in this chapter.

3.1 DIVISION OF WORLD INTO REGIONS

The world was divided into seven regions that may have some capability to provide CARBOB to California. These regions were defined by CEC at the outset of the study. Table 3.1-1 lists the regions which were considered:

TABLE 3.1-1
WORLD SUPPLY REGIONS

Pacific North West
United States Gulf Coast (USGC)
Caribbean
Europe
Latin America
Middle East
Far East

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The Pacific North West includes all the refineries within the state of Washington that can make gasoline. There are no refineries in Oregon that can make gasoline of any type.

The USGC includes the refineries in Petroleum Administration for Defense District (PADD) III. PADD III includes Texas, Louisiana, Mississippi, New Mexico and Alabama.

Caribbean includes the refineries in the U.S. Virgin Islands, Puerto Rico and island nations in the Caribbean. Caribbean has been defined to include refining centers in Aruba and Curacao near the coast of South America.

Europe includes refineries with coastal access in Europe including the UK, France, Germany, Italy, Netherlands, Austria, Belgium, Denmark, Finland, Greece, Ireland, Norway, Portugal, Spain, Sweden and Turkey. Two insignificant refineries in landlocked Switzerland have been included but do not influence the results of the analysis.

Latin America includes refineries in Mexico, and continental Central and South America.

Middle East includes the refineries in Abu Dhabi, Saudi Arabia, Iran, Iraq, Bahrain, Israel, Jordan, Kuwait, Oman, Qatar, Syria, and Yemen.

Far East includes the region from Pakistan to Japan and from China to New Zealand.

3.2 INTERVIEWS AND DISCUSSIONS

Discussions were held with representatives of each refiner in California producing CARB gasoline. As part of this interview process aspects of refinery operations important from a technical point of view to meeting CARB gasoline quality were identified. Further discussions were held with representatives of refiners who had historically provided imported CARB-complying gasoline as well as with representatives of other refiners and groups outside the state of California who could be reasonably expected to have insights into the possibility of fuel being provided from each region. These discussions were used to devise assessment criteria as well as cost factors that could be used to develop supply curves for CARBOB from outside the state.

3.3 CARB CAPABILITIES ASSESSMENT

Assessment criteria were developed that relate to the ability of refineries to produce CARBOB to refinery size and configuration. Variations on the assessment criteria were considered in light of the comments made by industry participants as well as a technical review of the suitability of various streams to produce CARBOB. A model was developed that scored each refinery in the world on the assessment criteria. The model is intended to provide relative capability measurement based on indicated process capability and not an absolute measure of a refinery's capability.

3.4 ALLOCATION OF REFINERIES INTO CAPABILITY CATEGORIES

Based on the results of the CARB Capabilities Assessment, each refinery in the world was allocated into one of two groups: those with a reasonable prospect of producing commercial quantities of CARB gasoline and those for which producing commercial quantities of CARB gasoline is unlikely to be practical.

3.5 KEY COMPONENT AVAILABILITY

Estimates were prepared of the total production of key CARBOB components in each region. The most critical component was identified as alkylate. Other important components include desulfurized straight run gasoline, hydrocrackate and reformate. An estimate was made of the volume of alkylate that could be made available for CARBOB production. The most intense reviews of alkylate availability were made for the Pacific

North West and USGC areas and were based on refiner comments as well as minimum requirements for other uses of alkylate.

3.6 CARBOB PRODUCTION RELATIONSHIPS

Typical gasoline blend stock characteristics for the various areas were reviewed in the context of the requirements of the predictive model. These reviews were used to estimate the relationship between the volume of potential CARBOB production and the volume of alkylate available for each region. The relationships between alkylate and CARBOB for the regions are variable based on the availabilities and qualities of the other blend stocks.

3.7 REGIONAL CARBOB CAPABILITY

An estimate was made of the volume of the gasoline produced from CARBOB-Capable refineries that could be produced as CARBOB gasoline. The volume of CARBOB was determined from the estimated volume of alkylate that could be made available and the relationship between CARBOB and alkylate for each region.

This step determines the volume of CARBOB that could be supplied from each region.

3.8 COST BASIS

A cost model was established that estimates total cost to supply CARBOB to California based on certain cost components including:

TABLE 3.8-1
CARBOB COST ELEMENTS

Local Gasoline Price
Processing Cost
Inventory Cost
Transportation Cost
Refiner Margin

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Each cost element was estimated for each region.

Local gasoline price was estimated relative to California gasoline prices based on historical relationships from the summer of 1997. This period was selected to be consistent with the price data used by Mathpro and ESAI. This element was included to reflect the market reality that refiners would be reluctant to price gasoline supplies away from local markets unless at least the locally prevailing price plus all cost elements would be provided.

Processing cost refers to costs incurred within the refinery to manufacture CARBOB instead of the local gasoline grade. These costs include the costs incurred to assign valuable blend stocks preferentially to CARBOB production rather than to regional gasoline production and costs incurred within the refinery to make small adjustments to processing or to make product segregations. The principal elements of the processing cost are debits and credits associated with butane blending, mostly vapor pressure. A small allowance was made for other costs such as laboratory testing, more severe debutanization and other incidental costs in the refinery.

Octane credit/debit refers to the cost element associated with the difference between the prevailing octane specification in the market and the required octane for the CARBOB. Gasoline price quotations carry with them octane specifications the fuel must meet. Because CARBOB is to be blended with high octane oxygenates on delivery to California, its octane specification can be much lower than most fuels. Refiners can benefit from this factor either in producing more higher octane premium fuel for their regional markets or by reducing processing severity improving yields and reducing costs. This factor generally reduces the cost of CARBOB.

Inventory holding costs refer to costs to consolidate cargo-quantities of CARBOB. These costs include a provision for terminaling costs at the point of origin as well as time value of holding inventory during shipping. The time value of holding the inventory is limited to costs of working capital and excludes any factor related to risk management or market changes during shipping.

Transportation costs refer to the costs to provide marine transportation and destination terminaling for CARBOB from the source to California points of entry. These costs are estimated based on prevailing shipping rates based on Worldscale with appropriate adjustments for ship size and condition for international movements and typical costs reported by market participants for domestic movements.

Refiner margin is the element over and above identifiable costs to provide adequate incentive for the out of state refiner to undertake the risks and efforts necessary to produce CARBOB.

3.9 SUPPLY CURVES

Based on CARBOB volumes from each region and their cost, supply curves were developed for each relevant case.

4. REFINING CAPACITY

In this section the total refinery capacity in each region is identified and discussed. Basic information about the refineries was taken from the Oil & Gas Journal Worldwide Refinery database. There were a few modifications of this data based on information developed independently by Purvin & Gertz.

4.1 PACIFIC NORTH WEST

Table 4.1-1 shows the refineries in the Pacific North West region. There are seven refineries in the region though this total includes two that are incapable of producing any gasoline: Chevron Seattle and Sound Tacoma. Of the remaining five refineries, four are affiliates of California refiners though the Shell refinery in Anacortes is being sold pursuant to an agreement with the Federal Trade Commission.

The ARCO refinery at Cherry Point is classified as a coking refinery but the facility has a hydrocracker, not the more common Fluid Catalytic Cracker (FCC). The Texaco refinery at Anacortes is also classified as a coking refinery. The Shell and Tosco refineries are classified as cracking refineries. The U.S. Oil & Refining facility is classified as a hydroskimming refinery.

The Pacific North West region is considered generally short of petroleum products. A large volume of products carried by pipeline are delivered to Portland, Oregon from Puget Sound refiners and is supplemented by products from California, other U.S. points of origin and even foreign sources. Nevertheless, there is considerable waterborne traffic in petroleum products south to California destinations, mostly in Los Angeles. Since so much of the capacity in the Pacific North West is controlled by California refiners, opportunities exist to optimize the systems of both areas together.

4.2 U.S. GULF COAST

Table 4.2-1 shows the USGC refineries. For purposes of this report the Gulf Coast has been defined to include all of PADD III. The bulk of these refineries are located in Texas and Louisiana with a small fraction of regional capacity found in Mississippi and Alabama. A small amount of the capacity included as Gulf Coast is in inland regions of West Texas or New Mexico. The Gulf Coast region contains many large sophisticated refineries and 21 of the refineries are classified as coking refineries. Another 16 are cracking refineries and the balance are unsophisticated hydroskimming and topping refineries.

Fourteen of the Gulf Coast refineries are affiliated with California refiners. These refineries represent forty percent of all capacity on the USGC.

PADD III refineries process far more crude oil than is needed to satisfy regional demand. Products from PADD III refineries are carried by major pipeline systems into East Coast and Midwest markets, and supply some parts of the Rocky Mountains, Arizona and northern Mexico. Inexpensive waterborne transportation allows cargoes from coastal refineries in PADD III to be shipped to foreign destinations which occurs from time to time. PADD III has been an historical supplier of occasional product shortfalls in California.

Only the Valero refinery in Corpus Christi was identified as an historical producer of CARB gasoline. Other Gulf Coast refineries are believed to have considered producing CARB gasoline in the past but not to have done so.

While the Gulf Coast refining industry is very large and has a justifiable reputation as being very sophisticated, the fraction of gasoline produced as reformulated actually is fairly limited by West Coast standards. Only about 18% of the gasoline produced in PADD III conforms to EPA reformulated fuel standards. That product is consumed in the Houston, Texas area which requires such fuels and is shipped to markets on the East Coast. Other market areas which consume large volumes of Gulf Coast products do not require reformulated gasoline.

The scale of the refining industry on the Gulf Coast, its proximity to California and historical role as an incremental California product supplier, and the large volume of alkylation capacity found on the Gulf Coast all suggest that these refineries would be logical suppliers of substantial volumes of CARBOB. The scarcity of historical CARB gasoline shipments from the Gulf Coast is thought to be primarily a cost and profitability issue rather than one of technical capability.

4.3 CARIBBEAN

Table 4.3-1 shows the Caribbean refineries. None of these is affiliated with any California refiner. Of these refineries, four are cracking refineries while the other ten are less sophisticated. Hess Oil Virgin Islands is the only historical producer of CARB reformulated gasoline in the region.

Several of the Caribbean area refineries are major product exporters. These include Hess in the Virgin Islands, Coastal in Aruba and Refineria Isla Curazao in Curacao. Of these three, Hess is the only one believed to be a regular manufacturer of U.S. reformulated gasoline. The others process heavy Venezuelan crude oils making lower quality products mostly for South American markets.

Most the refineries in the Caribbean are unlikely suppliers of CARB gasoline. The orientation of most of the refining capacity toward markets with lax specifications and historical disinterest by these refineries in supplying even EPA reformulated fuels suggests that they will not be a likely source of supply beyond the Hess refinery.

4.4 EUROPE

Table 4.4-1 shows the refineries in Europe. European refineries are a very diverse group including some very simple capacity and some extremely complex facilities. Twenty-three of the European refineries are affiliated with California refiners. These refiners represent about one quarter of all the refining capacity in Europe.

European refiners are an important source of imported refined products for the U.S. Imports originate mostly in Northwest Europe, particularly the U.K. and Rotterdam area refiners. The Neste Oy refinery in Porvoo, Finland, has produced CARB gasoline and routinely manufactures gasoline for export to the East Coast of the U.S. Finnish refinery capacity exceeds domestic requirements so the country is a regular exporter but it is a relatively low ranking source of imports for the U.S.

The growing sophistication of the European industry and the advent of some form of European Community reformulated fuels in the foreseeable future and their historical role as U.S. gasoline suppliers makes these refiners reasonable prospects for manufacturing CARBOB. Just as California refiners became more sophisticated when CARB reformulated fuels were mandated, the European refiners also are likely to become more sophisticated as European specifications are tightened. There is some prospect that marginal refiners will close their operations rather than invest for reformulated fuels and that more sophisticated refiners will expand to take their place. While the demand for the highest quality products will increase, the supply of such products also will increase as more refiners modify their operations to reduce sulfur content, benzene content and other environmentally unattractive attributes of their gasoline.

4.5 LATIN AMERICA

Table 4.5-1 shows the refineries in Latin America. The region covered by this designation includes Mexico and all of the Central and South American land mass. Island nations in the Caribbean including the islands off the coast of Venezuela, Trinidad, Curacao and Aruba, are not defined in this region and have been handled separately. The greatest concentration of Latin American capacity is in Argentina, Brazil, Mexico and Venezuela. Regional capacity is about 5.9 million barrels per day. About half the refineries in Latin America are simple topping or hydroskimming refineries. There are twenty seven cracking refineries and seven coking refineries in the region.

Five of the Latin American refineries are affiliated with California refiners. These refineries represent only about four percent of regional capacity.

Latin America has several major product exporting nations. The most important for the U.S. market is Venezuela which provides products primarily to East Coast markets. Brazil and Argentina export mostly to regional markets. Mexico, a large crude oil producer, is a net product importer and receives products from U.S. refiners mostly on the Gulf Coast.

4.6 MIDDLE EAST

Table 4.6-1 shows the 46 refineries identified in the Middle East. These refineries have a total capacity of about 5.8 million barrels per day. Most Middle East refineries have simple configurations though there are some large, relatively sophisticated refineries oriented toward product exports.

Two of the Middle East refineries, both in Saudi Arabia, are affiliated with California refiners. These two facilities have about 600,000 barrels per day of capacity, or about 11 percent of regional refinery capacity.

The Middle East has considerable export-oriented refinery capacity. These refineries are used to process local crude oils which otherwise would be exported into products prior to export.

The combination of sour crude oil qualities, relatively lax product specifications in traditional markets and poor sophistication, makes Middle East refiners as a group unlikely CARBOB suppliers. Simple configurations combined with sour crude quality indicates that most refineries are likely to have difficulty meeting CARB sulfur specifications. Most Middle East product export is naphthas, distillates and high sulfur residual fuel oil products. Gasoline is a relatively low volume export from most areas. Most of the markets served by Middle East refineries lie in Asia and East Africa. Markets which rely heavily on Middle East imports tend to use high sulfur products and at best moderate gasoline qualities.

4.7 FAR EAST

Table 4.7-1 shows the refineries in the Far East. About one third of these refineries are in China, mostly small simple facilities. Another quarter are in Japan. The balance are very widely distributed.

Far East markets are quite diverse and product quality specifications vary widely. Some refiners process exceptionally sweet crude oils reducing the likelihood of sulfur difficulties. There are many aromatics extraction plants which would be beneficial in removing objectionable aromatics and benzene from some gasoline streams. Many Far Eastern markets are now consuming unleaded gasoline though reformulated fuels programs are still in the future.

Major refining centers in Japan, Korea, Singapore and China hold the promise of supplying some CARBOB. Some of the facilities are fairly sophisticated and utilize attractive hydrocracking technology. Hydrocracking is used in many Asian refineries rather than the more common FCC technology in order to maximize distillate yields. Distillates are more important products in the Far East than they are in most other markets. A benefit of hydrocracking is that it also produces very low sulfur gasoline streams that can be useful for manufacturing CARBOB.

4.8 OTHER

There are areas of the world that are excluded from this analysis mostly because they have little prospect of supplying gasoline to California at all. These areas include Canada, central and Rocky Mountain areas of the U.S., the U.S. East Coast, the Former Soviet Union (FSU) and Central Asia, and Africa. Canada has insignificant refining capacity on the West Coast and is an impractical California supplier from other Canadian regions for logistical reasons. The Rocky Mountain areas of the U.S. have scant refining capacity and no practical method of delivering significant volumes of gasoline to the West Coast. Likewise the central U.S. has no practical method of delivering to the West Coast. The U.S. East Coast is a major gasoline importing region and therefore is an unlikely source of fuels for California. FSU and Central Asia has little ability to produce high quality fuels of any type and certainly not CARB gasoline. Furthermore, FSU refineries are not logistically positioned to be ready fuel exporters of waterborne cargoes. Africa is an impractical supplier of products and does not generally export refined fuels of any type.

Notwithstanding that the areas discussed above were excluded from the study areas, their refinery capabilities were scanned nevertheless to identify any refineries likely to be able to manufacture CARBOB. While there are some refineries, particularly on the East Coast of the U.S., that can manufacture high quality fuels, no refineries were identified that would have a reasonable prospect of supplying CARBOB to California in these areas. On the basis of this review, the original region descriptions were reconfirmed for further analysis.

Table 4.8-1 shows the capacity of refineries in the U.S. that were excluded from the analysis. This includes all the California refineries and the other states not expected to contribute to external supplies.

Table 4.8-2 shows the capacities of refineries outside the U.S. that are not included in the supply areas. Though there is nearly 16 million barrels of capacity in these refineries, there is an aggregate of only about 50,000 barrels per day of alkylation capacity. Apart from the logistical problems that preclude most of these refineries from contributing to external CARBOB supplies, their low level of technical sophistication suggests they wouldn’t be able to manufacture appreciable volumes of CARBOB.

Table 4.8-3 shows the refineries in the Other U.S. region that are affiliates of California refiners. Table 4.8-4 shows the refineries in the Other region that are affiliates of California refiners.

TABLE 4.1-1
REGIONAL REFINERY CAPACITY, PACIFIC NORTH WEST
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
ARCO	Ferndale	WA	202,000	51,000	0	50,000	0	0	0
Shell Oil	Anacortes	WA	108,200	0	44,800	0	11,500	0	0
Sound Refining	Tacoma	WA	11,900	0	0	0	0	0	0
Texaco	Anacortes	WA	135,850	22,050	47,700	0	8,550	0	0
Tosco	Ferndale	WA	88,500	0	25,000	0	6,000	0	0
U.S. Oil & Refining	Tacoma	WA	40,800	0	0	0	0	0	0
		TOTAL	**575,350**	**73,050**	**117,500**	**50,000**	**26,050**	**0**	**0**

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TABLE 4.1-2
REGIONAL REFINERY CAPACITY, PACIFIC NORTH WEST- California Affiliates
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
ARCO	Ferndale	WA	202,000	51,000	0	50,000	0	0	0
Chevron	Seattle	WA	0	0	0	0	0	0	0
Shell Oil (1)	Anacortes	WA	108,200	0	44,800	0	11,500	0	0
Texaco	Anacortes	WA	135,850	22,050	47,700	0	8,550	0	0
Tosco	Ferndale	WA	88,500	0	25,000	0	6,000	0	0
		Total	**534,550**	**73,050**	**117,500**	**50,000**	**26,050**	**0**	**0**

Note: Shell Anacortes is for sale pursuant to Federal Trade Commission requirements.

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TABLE 4.2-1
REGIONAL REFINERY CAPACITY, U.S. GULF COAST
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Coastal Ref. & Mkt.	Mobile Bay	AL	15,000	0	0	0	0	0	0
Hunt Refining Co.	Tuscaloosa	AL	43,225	10,800	0	0	0	0	0
Shell Oil Products Co.	Saraland	AL	76,000	0	0	0	0	0	7,500
AIPC	Lake Charles	LA	27,600	0	0	0	0	0	0
Atlas Processing	Shreveport	LA	46,200	0	0	0	0	0	0
Basis Petroleum, Inc.	Krotz Springs	LA	67,100	0	30,700	0	0	0	0
BP Oil Co.	Belle Chasse	LA	242,250	22,500	92,700	0	34,200	21,150	0
Calcasieu Refining	Lake Charles	LA	14,000	0	0	0	0	0	0
Calumet	Princeton	LA	8,000	0	0	0	0	0	0
Calumet Lubricants Co.	Cotton Valley	LA	8,740	0	0	0	0	0	0
Canal Refining Co.	Church Point	LA	9,000	0	0	0	0	0	0
CITGO	Lake Charles	LA	304,000	84,600	117,000	36,000	20,700	4,500	0
Conoco	Lake Charles/Westlake	LA	226,000	65,000	50,000	26,600	10,400	0	0
Exxon	Baton Rouge	LA	432,000	99,000	204,000	22,500	35,000	0	0
Marathon Oil	Garyville	LA	225,000	0	90,000	0	26,000	0	0
Mobil Oil	Chalmette	LA	176,400	33,300	62,000	20,000	12,000	9,600	0
Murphy Oil	Meraux	LA	95,000	0	36,000	0	8,000	0	0
Placid Refining	Port Allen	LA	48,000	0	19,000	0	3,800	0	0
Shell Chemical Co.	St. Rose	LA	40,000	0	0	0	0	0	0
Shell Oil	Norco	LA	218,000	24,500	108,000	35,000	15,000	0	0
Star Enterprise	Convent	LA	230,000	0	82,500	45,000	13,050	0	0
Chevron	Pascagoula	MS	295,000	71,000	63,000	58,000	14,800	15,100	0
Ergon Refining	Vicksburg	MS	25,000	0	0	0	0	0	0
Southland Oil	Lumberton	MS	5,800	0	0	0	0	0	0
Southland Oil	Sandersville	MS	11,000	0	0	0	0	0	0
Giant Industries	Gallup	NM	20,800	0	8,500	0	1,800	0	0
Giant Refining Co.	Bloomfield	NM	16,800	0	5,331	0	0	0	0
Navajo Refining	Artesia	NM	60,000	0	18,500	0	9,400	0	0

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TABLE 4.2-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, U.S. GULF COAST
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
AGE Refining & Manufacturing	San Antonio	TX	5,000	0	0	0	0	0	0
Amoco Oil	Texas City	TX	433,000	34,200	196,700	114,000	58,900	42,800	0
Basis Petroleum, Inc.	Houston	TX	67,600	0	58,500	0	10,400	5,700	0
Basis Petroleum, Inc.	Texas City	TX	125,400	0	48,000	0	5,700	0	0
Chevron	El Paso	TX	90,000	2,400	28,000	0	8,200	0	0
CITGO	Corpus Christi	TX	130,000	36,000	77,000	0	21,000	*0*	0
Clark	Port Arthur	TX	185,000	33,000	63,000	0	15,500	9,800	0
Coastal Ref. & Mkt.	Corpus Christi	TX	95,000	12,000	20,000	18,500	3,200	17,500	0
Crown Central	Houston	TX	100,000	11,250	50,400	0	11,700	0	0
Deer Park Refining	Deer Park	TX	255,700	61,300	64,900	62,600	16,500	17,900	0
Diamond Shamrock	Sunray/McKee	TX	135,000	0	45,000	25,000	8,700	0	0
Diamond Shamrock	Three Rivers	TX	80,000	0	20,000	25,000	6,000	0	0
Exxon	Baytown	TX	411,000	31,000	190,000	24,000	28,000	0	0
Fina Oil & Chemical	Big Spring	TX	58,000	0	22,500	0	5,000	1,000	0
Fina Oil & Chemical	Port Arthur	TX	178,500	0	61,000	0	5,500	13,000	0
Howell Hydrocarbons	Channelview	TX	2,400	0	0	0	0	0	0
Koch Refining	Corpus Christi	TX	280,000	15,000	92,000	15,000	20,000	36,000	0
LaGloria Oil & Gas	Tyler	TX	52,000	5,400	16,500	0	4,200	0	0
Lyondell-CITGO	Houston	TX	258,000	42,000	92,000	0	20,900	13,700	0
Marathon Oil	Texas City	TX	70,000	0	32,000	0	10,000	2,500	0
Mobil Oil	Beaumont	TX	320,000	45,500	100,000	50,000	12,200	0	14,400
NTPS	Corpus Christi	TX	30,000	0	0	0	0	0	0
Phillips 66 Co.	Borger	TX	120,000	0	57,000	0	17,500	0	13,500
Phillips 66 Co.	Sweeny	TX	200,000	0	91,600	0	19,000	5,300	9,000
Pride Refining	Abilene	TX	44,800	0	0	0	0	0	0
Shell Oil	Odessa	TX	28,300	0	9,600	0	3,200	0	0
Star Enterprise	Port Arthur	TX	235,000	49,500	83,000	17,820	18,000	0	0
Valero Refining Co.	Corpus Christi	TX	29,900	0	64,000	30,000	10,800	0	0
		TOTAL	**7,005,515**	**789,250**	**2,569,931**	**625,020**	**544,250**	**215,550**	**44,400**

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TABLE 4.2-2
REGIONAL REFINERY CAPACITY, U.S. GULF COAST- California Affiliates
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Shell Oil Products Co.	Saraland	AL	76,000	0	0	0	0	0	7,500
Exxon	Baton Rouge	LA	432,000	99,000	204,000	22,500	35,000	0	0
Mobil Oil	Chalmette	LA	176,400	33,300	62,000	20,000	12,000	9,600	0
Shell Chemical Co.	St. Rose	LA	40,000	0	0	0	0	0	0
Shell Oil	Norco	LA	218,000	24,500	108,000	35,000	15,000	0	0
Star Enterprise	Convent	LA	230,000	0	82,500	45,000	13,050	0	0
Chevron	Pascagoula	MS	295,000	71,000	63,000	58,000	14,800	15,100	0
Chevron	El Paso	TX	90,000	2,400	28,000	0	8,200	0	0
Diamond Shamrock	Sunray/McKee	TX	135,000	0	45,000	25,000	8,700	0	0
Diamond Shamrock	Three Rivers	TX	80,000	0	20,000	25,000	6,000	0	0
Exxon	Baytown	TX	411,000	31,000	190,000	24,000	28,000	0	0
Mobil Oil	Beaumont	TX	320,000	45,500	100,000	50,000	12,200	0	14,400
Shell Oil	Odessa	TX	28,300	0	9,600	0	3,200	0	0
Star Enterprise	Port Arthur	TX	235,000	49,500	83,000	17,820	18,000	0	0
		Total	**2,793,700**	**356,200**	**995,100**	**322,320**	**174,150**	**24,700**	**21,900**

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TABLE 4.3-1
REGIONAL REFINERY CAPACITY, CARIBBEAN
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Aruba	Coastal Aruba Refining Co. N.V.	San Nicolas	210,000	27,900	0	38,000	0	0	0
Barbados	Mobil Oil Barbados Ltd.	Bridgetown	6,000	0	0	0	0	0	0
Cuba	Government	Nico Lopez, Havana	121,800	0	14,700	0	0	0	0
Cuba	Government	Cabaiguan	2,100	0	0	0	0	0	0
Cuba	Government	Santiago de Cuba	101,500	0	0	0	0	0	0
Cuba	Government	Cienfuegos	76,000	0	0	0	0	0	0
Dominican Republic	Falconbridge Dominicana C por A	La Bonao	16,000	0	0	0	0	0	0
Dominican Republic	Refineria Dominicana de Petroleo SA	Haina	34,000	0	0	0	0	0	0
Jamaica	Petrojam Ltd.	Kingston	35,500	0	0	0	0	0	0
Martinique	Ste. Anonyme de la Raffinerie des Antilles	Fort-de-France	16,000	0	0	0	0	0	0
Netherlands Antilles	Refineria Isla Curazao SA	Emmastad	320,000	0	49,000	0	8,020	0	0
Puerto Rico	Puerto Rico Sun Oil Co.	Yabucoa	85,000	0	0	15,600	0	0	0
Trinidad	Trinidad and Tobago Oil CL	Pointe-a-Pierre	165,000	0	25,000	0	1,200	1,700	0
Virgin Islands	Hess Oil Virgin Islands Corp.	St. Croix	545,000	0	125,000	0	14,000	30,000	15,000
		TOTAL	**1,733,900**	**27,900**	**213,700**	**53,600**	**23,220**	**31,700**	**15,000**

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TABLE 4.3-2
REGIONAL REFINERY CAPACITY, CARIBBEAN- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
No California Affiliates in the Caribbean Region									

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TABLE 4.4-1
REGIONAL REFINERY CAPACITY, EUROPE
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Austria	OeMV	Schwechat	210,000	0	25,800	0	0	0	0
Belgium	Belgian Refining Corp. NV	Antwerp	80,750	0	0	0	0	0	0
Belgium	Esso Belgium	Antwerp	246,000	0	33,300	0	6,815	0	0
Belgium	Fina Raffinaderij Antwerpen-	Antwerp	288,000	0	77,600	0	6,700	0	0
Belgium	Nynas Petroleum NV	Antwerp	15,000	0	0	0	0	0	0
Denmark	AS Dansk Shell	Fredericia	66,700	0	0	0	0	0	0
Denmark	Dansk Statoil AS	Kalundborg	88,000	0	0	0	0	0	0
Denmark	Kuwait Petroleum Refining	Gulfhavn (Skaelskoer)	57,400	0	0	0	0	0	0
Finland	Neste Oy	Porvoo	200,000	0	31,000	16,000	4,200	0	3,600
Finland	Neste Oy	Naantali	40,000	0	14,200	0	0	0	0
France	Total France	La Mede	127,000	0	30,000	0	3,000	0	0
France	Total France	Gonfreville L'Orcher	333,000	0	41,000	0	0	0	0
France	Total France	Mardyck	127,000	0	32,000	0	0	0	0
France	Cie. Rhenane de Raffinage	Reichstett-Vendenheim	82,000	0	14,000	0	0	0	0
France	Elf France	Donges	214,300	0	49,400	0	4,300	0	0
France	Elf France	Feyzin	128,130	0	24,940	0	3,500	2,200	0
France	Elf France	Grandpuits	98,000	0	30,720	0	3,150	0	0
France	Esso SAF	Port Jerome	156,000	0	29,500	0	5,900	0	0
France	Esso SAF	Fos sur Mer	117,000	0	25,000	0	0	0	0
France	Mobil Oil Francaise	Notre Dame de Gravenchon	63,650	0	0	0	0	0	0
France	Shell Francaise	Berre l'Etang	127,000	0	34,000	0	0	0	0
France	Shell Francaise	Petit Couronne	141,000	0	20,000	0	0	0	0
France	Ste. Francaise des Petroles BP	Lavera	199,500	0	27,900	15,300	0	6,600	0

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TABLE 4.4-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, EUROPE
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Germany	BETA	Wihelmshaven	180,000	0	0	0	0	0	0
Germany	BP/AGIP	Vohburg/Ingolstadt	114,000	0	35,100	0	0	0	0
Germany	DEA Mineraloel AG	Wesseling	120,000	0	0	40,000	0	7,600	0
Germany	DEA Mineraloel AG	Heide	98,000	0	9,000	0	0	5,800	0
Germany	Deutsche Shell AG	Godorf	170,000	0	0	36,000	0	17,000	0
Germany	Deutsche Shell AG	Harburg-Grasbrook	98,000	0	16,000	0	0	0	0
Germany	Erdoel Raffinerie Neustadt GmbH	Neustadt-Donau	144,000	0	23,400	0	0	0	0
Germany	Esso AG	Ingolstadt	105,000	0	27,500	0	0	0	0
Germany	Holburn Europa Raffinerie GmbH	Harburg	78,000	0	18,750	0	0	0	0
Germany	Leune-Werke AG	Leuna	100,000	0	0	40,000	6,000	0	0
Germany	Mineraloel Oberrhein	Karlsruhe	325,800	21,000	74,000	0	10,200	0	0
Germany	OMV Mineralol Petrochemie	Burghausen	72,000	27,500	0	0	0	2,300	0
Germany	PCK Schwedt AG	Schwedt	230,000	0	51,000	0	6,100	5,000	0
Germany	Ruhr Oel GmbH	Gelsenkirchen	227,000	28,000	21,000	30,000	0	*3,650*	0
Germany	Schmierstoff Raffinerie	Salzbergen	3,100	0	0	0	0	0	0
Germany	Wintershall AG	Lingen	80,000	18,000	0	23,000	0	4,674	0
Greece	Hellenic Aspropyrgos Refinery SA	Aspropyrgos	121,000	0	36,000	0	0	0	0
Greece	Motor Oil (Hellas)	Aghii Theodori	100,000	0	30,400	0	2,400	0	5,200
Greece	Petrola Hellas SA	Elefsis	108,000	0	0	0	0	0	0
Greece	Thessaloniki Refining Co. AE	Thessaloniki	66,500	0	0	0	0	0	0
Ireland	Irish Refining Petroleum Corp. Ltd.	Whitegate	65,000	0	0	0	0	0	0

TABLE 4.4-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, EUROPE
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Italy	Agip Plus SpA	Livorno	84,000	0	0	0	0	0	0
Italy	Agip Raffinazione	Sannazzaro, Pavia	200,000	0	34,000	30,000	3,200	0	0
Italy	Agip Raffinazione	Taranto	84,000	0	0	16,000	0	0	0
Italy	Agip Raffinazione	Porto Marghera	80,000	0	0	0	0	0	0
Italy	Anonima Petroli Italiana	Falconara, Marittima	77,000	0	0	0	0	0	0
Italy	Arcola Petrolifera SpA	La Spezia	33,000	0	0	0	0	0	0
Italy	ENI	Priolo	220,000	0	32,000	0	4,000	12,000	0
Italy	Esso Italiana SpA	Augusta, Siracusa	182,500	0	43,200	0	7,900	0	0
Italy	Iplom SpA	Busalla	46,500	0	0	0	0	0	0
Italy	Isab	Priolo Gargallo Melilli	235,000	0	0	65,000	0	0	0
Italy	Italiana Energia E Servizi SpA	Frassino, Mantova	50,318	0	0	0	0	0	0
Italy	Raffineria di Roma SpA	Rome	81,500	0	0	0	0	0	0
Italy	Raffineria Mediterranea SrL	Milazzo	160,000	0	49,000	50,000	5,000	0	0
Italy	Raffineria Siciliana Srl	Gela	105,000	45,000	35,000	0	10,000	6,700	0
Italy	Saras SpA	Sarroch	285,000	0	80,000	50,000	6,800	0	0
Italy	Sarpom	S. Martino Di Trecate	248,000	0	25,200	0	0	0	0
Italy	Tamoil Italia SpA	Cremona	90,000	0	0	0	0	0	0
Netherlands	Esso Nederland BV	Rotterdam	180,000	36,660	0	33,850	0	12,000	0
Netherlands	Kuwait Petroleum Europoort BV	Rotterdam	75,500	0	0	0	0	0	0
Netherlands	Netherlands Refining Co. NV	Europort & Pernis	399,000	0	53,000	0	5,850	0	0
Netherlands	Shell Nederland Raffinaderij BV	Pernis	374,000	0	87,000	22,000	6,800	0	0
Netherlands	Smid & Hollander Raffinaderij BV	Amsterdam	10,000	0	0	0	0	0	0
Netherlands	Total Raffinaderij Nederland NV	Vlissingen	148,000	0	0	39,000	0	0	0

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TABLE 4.4-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, EUROPE
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Norway	Esso Norge AS	Slagen-Valloy	100,000	0	0	0	0	0	0
Norway	Norske Shell AS	Sola	53,000	0	0	0	0	0	0
Norway	Rafinor AS	Mongstad	154,000	25,000	48,000	0	0	0	0
Portugal	Petrogal	Sines	212,895	0	31,500	0	5,400	0	0
Portugal	Petrogal	Leca da Palmeira Porto	91,277	0	0	0	0	6,282	0
Spain	Asfaltos Espanoles SA	Tarragona	21,000	0	0	0	0	0	0
Spain	Cia. Espanola de Petroles	San Roque (Cadiz)	205,000	0	40,000	0	5,000	13,100	10,000
Spain	Cia. Espanola de Petroles	La Rabida Huelva	100,000	0	18,000	0	0	2,420	0
Spain	Cia. Espanola de Petroles	Tenerife	89,000	0	0	0	0	0	0
Spain	Petroleos del Mediterraneo	Castellon de la Plana	101,650	0	22,500	0	0	0	0
Spain	Petronor SA	Somorrostro Vizcaya	209,000	0	39,600	0	4,496	0	0
Spain	Repsol Petroleo SA	Puertollano, Ciudad Real	135,000	16,000	30,000	0	3,300	1,800	0
Spain	Repsol Petroleo SA	Tarragona	180,000	0	0	15,000	0	0	0
Spain	Repsol Petroleo SA	La Coruna	135,000	13,500	28,000	0	0	0	0
Spain	Repsol Petroleo SA	Cartagena Murcia	120,000	0	0	0	0	0	0
Sweden	AB Nynas Petroleum	Gothenburg	12,500	0	0	0	0	0	0
Sweden	AB Nynas Petroleum	Nynashamn	28,000	0	0	0	0	0	0
Sweden	OK Petroleum	Gothenburg	106,000	0	0	0	0	0	0
Sweden	Shell Raffinaderi BV	Gothenburg	81,000	0	0	0	0	0	0
Sweden	Skandinaviska Raffinaderi AB	Brofjorden-Lysekil	200,000	0	29,700	48,600	0	0	0
Switzerland	Raffinerie de Cressier SA	Cressier	60,000	0	0	0	0	0	0
Switzerland	Raffinerie du Sud-Ouest SA	Collombey	72,000	0	0	0	0	0	0

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TABLE 4.4-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, EUROPE
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Turkey	Anadolu Tasfiyehanesi AS	Mersin	95,000	0	0	0	0	5,800	0
Turkey	Turkish Petroleum Refineries Corp.	Izmit	251,600	0	22,645	23,000	0	0	0
Turkey	Turkish Petroleum Refineries Corp.	Aliaga-Izmir	226,440	0	15,095	16,500	0	0	0
Turkey	Turkish Petroleum Refineries Corp.	Kirkkale	113,220	0	0	14,500	0	0	0
Turkey	Turkish Petroleum Refineries Corp.	Batman, Siirt	22,015	0	0	0	0	0	0
United Kingdom	BP Refinery Grangemouth Ltd.	Grangemouth	194,750	0	18,900	31,500	4,500	1,000	0
United Kingdom	Conoco Ltd.	South Killingholme	180,000	70,000	50,000	0	14,000	4,500	0
United Kingdom	Eastham Refinery Ltd.	Eastham, Cheshire	22,000	0	0	0	0	0	0
United Kingdom	Elf Oil Ltd.	Milford Haven	108,000	0	32,500	0	6,400	0	0
United Kingdom	Esso Petroleum CL	Fawley	317,000	0	85,000	0	0	0	0
United Kingdom	Gulf Oil GB	Milford Haven	112,000	0	0	0	0	0	0
United Kingdom	Lindsey Oil Refinery Ltd.	Killingholm South Humberside	192,000	0	48,400	0	6,300	0	0
United Kingdom	Mobil Oil CL	Coryton Essex	171,000	0	56,250	0	18,000	0	0
United Kingdom	Nynas	Dundee	10,240	0	0	0	0	0	0
United Kingdom	Pembroke Cracking Co. (1)	Milford Haven	0	0	90,000	0	33,000	0	0
United Kingdom	Phillips Imperial Petroleum Ltd.	Port Clarence	100,000	0	0	0	0	0	0
United Kingdom	Shell U.K. Ltd.	Stanlow	262,000	0	73,000	0	11,000	9,000	0
United Kingdom	Shell U.K. Ltd.	Shell Haven	92,000	0	0	24,000	0	0	0
United Kingdom	Texaco Ltd.	Pembroke, Dyfed	180,000	0	0	0	0	0	0
		TOTAL	**14,374,735**	**300,660**	**2,100,000**	**679,250**	**223,211**	**129,426**	**18,800**

Note: (1) 65% Texaco 35% Gulf Oil GB.

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TABLE 4.4-2
REGIONAL REFINERY CAPACITY, EUROPE- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Belgium	Esso Belgium	Antwerp	246,000	0	33,300	0	6,815	0	0
Denmark	AS Dansk Shell	Fredericia	66,700	0	0	0	0	0	0
France	Esso SAF	Port Jerome	156,000	0	29,500	0	5,900	0	0
France	Esso SAF	Fos sur Mer	117,000	0	25,000	0	0	0	0
France	Mobil Oil Francaise	Notre Dame de Gravenchon	63,650	0	0	0	0	0	0
France	Shell Francaise	Berre l'Etang	127,000	0	34,000	0	0	0	0
France	Shell Francaise	Petit Couronne	141,000	0	20,000	0	0	0	0
Germany	Esso AG	Karlsruhe	0	0	0	0	0	0	0
Germany	Esso AG	Ingolstadt	105,000	0	27,500	0	0	0	0
Germany	Mobil Oil AG	Woerth	0	0	0	0	0	0	0
Italy	Esso Italiana SpA	Augusta, Siracusa	182,500	0	43,200	0	7,900	0	0
Netherlands	Esso Nederland BV	Rotterdam	180,000	36,660	0	33,850	0	12,000	0
Netherlands	Shell Nederland Raffinaderij BV	Pernis	374,000	0	87,000	22,000	6,800	0	0
Netherlands	Texaco	Pernis	0	0	0	0	0	0	0
Norway	Esso Norge AS	Slagen-Valloy	100,000	0	0	0	0	0	0
Norway	Norske Shell AS	Sola	53,000	0	0	0	0	0	0
Sweden	Shell Raffinaderi BV	Gothenburg	81,000	0	0	0	0	0	0
Sweden	Skandinaviska Raffinaderi AB	Brofjorden-Lysekil	200,000	0	29,700	48,600	0	0	0
United Kingdom	Esso Petroleum CL	Fawley	317,000	0	85,000	0	0	0	0
United Kingdom	Mobil Oil CL	Coryton Essex	171,000	0	56,250	0	18,000	0	0
United Kingdom	Shell U.K. Ltd.	Stanlow	262,000	0	73,000	0	11,000	9,000	0
United Kingdom	Shell U.K. Ltd.	Shell Haven	92,000	0	0	24,000	0	0	0
United Kingdom	Texaco Ltd.	Pembroke, Dyfed	180,000	0	0	0	0	0	0
		Total	**3,214,850**	**36,660**	**543,450**	**128,450**	**56,415**	**21,000**	**0**

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TABLE 4.5-1
REGIONAL REFINERY CAPACITY, LATIN AMERICA
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-Cracking	Alkylation	Aromatics	Isom
Argentina	Destileria Argentina	Lomas de Zamora	8,000	0	0	0	0	0	0
Argentina	Esso SAPA	Campana	88,100	25,000	27,300	0	0	0	0
Argentina	Esso SAPA	Puerto Galvan	19,000	0	0	0	0	0	0
Argentina	Isaura SA	Bahia Blanca	28,980	0	7,076	0	0	0	0
Argentina	Shell Cia. Argentina	Dock Sud	121,700	0	29,200	0	1,700	0	0
Argentina	Sol Petroleo SA	San Francisco Solana, Quillmes	6,000	0	0	0	0	0	0
Argentina	YPF	Lujan de Cuyo	120,000	35,200	44,700	26,000	0	0	0
Argentina	YPF	La Plata	176,000	39,000	73,600	0	0	0	0
Argentina	YPF	Plaza Huincul	23,600	0	0	0	0	0	0
Argentina	YPF	Campo Duran	32,000	0	0	0	0	0	0
Argentina	YPF	Dock Sud	4,000	0	0	0	0	0	0
Argentina	YPF	San Lorenzo	37,600	0	0	0	0	0	0
Bolivia	YPFB	Cochabamba	25,888	0	0	0	0	0	0
Bolivia	YPFB	Santa Cruz	19,000	0	0	0	0	0	0
Bolivia	YPFB	Sucre	3,000	0	0	0	0	0	0
Brazil	REFAP	Canoas, Rio Grande do Sul	68,230	0	14,040	0	0	0	0
Brazil	REFCAP	Maua Santo Andre, Sao Paulo	38,100	0	11,580	0	0	0	0
Brazil	DRGP	Rio Grande do Sul	12,500	0	3,000	0	0	0	0
Brazil	REDUC	Duque de Caxias, Rio de Janeiro	225,730	15,720	41,360	0	0	0	0
Brazil	REGAP	Betim, Minas Gerais	136,470	0	33,080	0	0	0	0
Brazil	REVAP	Sao Jose dos Campos, Sao Paulo	204,700	0	57,900	0	0	0	0
Brazil	RLAM	Mataripe, Bahia	117,960	0	24,810	0	0	0	0
Brazil	REMAN	Manaus, Amazonas	10,230	0	2,200	0	0	0	0
Brazil	REPLAN	Paulinia, Sao Paulo	272,930	0	50,314	0	0	0	0
Brazil	RPBC	Cubatao, Sao Paulo	155,325	32,700	49,620	0	3,140	7,550	0
Brazil	REPAR	Araucaria, Parana	159,210	0	45,700	0	0	0	0
Brazil	RPM	Rio de Janeiro	10,000	0	0	0	0	0	0

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TABLE 4.5-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, LATIN AMERICA
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-Cracking	Alkylation	Aromatics	Isom
Chile	ENAP	Gregorio-Magallanes	9,650	0	0	0	0	0	0
Chile	Petrox SA	Talcahuano	100,640	0	20,757	0	0	0	0
Chile	Refineria de Concon	Concon	82,000	0	25,000	12,580	1,100	0	0
Colombia	ECO Petrol	Barrancabermeja-Santander	173,000	0	64,000	0	2,100	1,600	0
Colombia	ECO Petrol	Cartagena, Bolivar	70,000	0	26,000	0	0	0	0
Colombia	ECO Petrol	Orito, Putumayo	1,800	0	0	0	0	0	0
Colombia	ECO Petrol	Tibu, N. de Santander	1,800	0	0	0	0	0	0
Colombia	ECO Petrol	Apiay	2,250	0	0	0	0	0	0
Costa Rica	Refinadora Costarricense	Limon	15,000	0	0	0	0	0	0
Ecuador	Petroecuador	Esmeraldas	90,000	0	0	0	0	*0*	0
Ecuador	Petroecuador	Sta. Elena Peninsula	47,000	0	0	0	0	0	0
Ecuador	Petroecuador	Refineria Amazonas	20,000	0	0	0	0	0	0
Ecuador	Petroecuador	Lago-Agrio	1,000	0	0	0	0	0	0
El Salvador	Refineria Petrolera Acajutla	Acajutla	20,500	0	0	0	0	0	0
Guatemala	Basic Resources International	Peten	4,000	0	0	0	0	0	0
Guatemala	Texas Petroleum Co.	Escuintla	16,000	0	0	0	0	0	0
Honduras	Refineria Texas de Honduras	Puerto Cortes	14,000	0	0	0	0	0	0
Mexico	Pemex	Ciudad Madero	195,000	10,000	43,000	0	3,420	0	0
Mexico	Pemex	Salamanca	240,000	0	60,000	18,500	0	0	0
Mexico	Pemex	Minatitlan	200,000	0	40,000	0	0	17,150	0
Mexico	Pemex	Cadereyta	235,000	0	40,000	0	0	0	0
Mexico	Pemex	Salina Cruz	330,000	0	80,000	0	14,100	0	0
Mexico	Pemex	Tula Hidalgo	320,000	0	80,000	0	0	0	0

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TABLE 4.5-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, LATIN AMERICA
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-Cracking	Alkylation	Aromatics	Isom
Nicaragua	Esso Standard Oil SA Ltd.	Managua	16,500	0	0	0	0	0	0
Panama	Refineria Panama SA	Las Minas	60,000	0	0	0	0	0	0
Paraguay	Petroleos Paraguayos	Villa Elisa	7,500	0	0	0	0	0	0
Peru	Maples Gas	Pucallpa	3,250	0	0	0	0	0	0
Peru	Petroleos del Peru	La Pampilla Lima	100,000	0	6,700	0	0	0	0
Peru	Petroleos del Peru	Marsella Loreto	0	0	0	0	0	0	0
Peru	Petroleos del Peru	Conchan/Lima	6,500	0	0	0	0	0	0
Peru	ANC	Talara	62,000	0	16,600	0	0	0	0
Peru	Petroleos del Peru	Iquitos Loreto	10,500	0	0	0	0	0	0
Uruguay	ANC	La Teja Montevideo	40,000	0	9,000	0	0	0	0
Venezuela	Corpoven	El Palito Carabobo	115,000	0	52,000	0	20,000	3,500	0
Venezuela	Corpoven	Puerto La Cruz Anzoategui	195,000	0	13,000	0	4,100	0	0
Venezuela	Corpoven	El Toreno Barinas	4,800	0	0	0	0	0	0
Venezuela	Corpoven	San Roque, Anzoategui	5,200	0	0	0	0	0	0
Venezuela	Lagoven	Judibana Falcon	571,000	52,100	97,200	0	17,800	0	0
Venezuela	Maraven	Punta Cardon Falcon	286,000	0	72,700	0	28,800	0	0
		TOTAL	**5,796,143**	**209,720**	**1,261,437**	**57,080**	**96,260**	**29,800**	**0**

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TABLE 4.5-2
REGIONAL REFINERY CAPACITY, LATIN AMERICA- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-Cracking	Alkylation	Aromatics	Isom
Argentina	Esso SAPA	Campana	88,100	25,000	27,300	0	0	0	0
Argentina	Esso SAPA	Puerto Galvan	19,000	0	0	0	0	0	0
Argentina	Shell Cia. Argentina de Petroleo SA	Dock Sud	121,700	0	29,200	0	1,700	0	0
Barbados	Mobil Oil Barbados Ltd.	Bridgetown	6,000	0	0	0	0	0	0
Guatemala	Texas Petroleum Co.	Escuintla	16,000	0	0	0	0	0	0
Honduras	Refineria Texas de Honduras	Puerto Cortes	14,000	0	0	0	0	0	0
Nicaragua	Esso Standard Oil SA Ltd.	Managua	16,500	0	0	0	0	0	0
Panama	Refineria Panama SA	Las Minas	60,000	0	0	0	0	0	0
		Total	**341,300**	**25,000**	**56,500**	**0**	**1,700**	**0**	**0**

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TABLE 4.6-1
REGIONAL REFINERY CAPACITY, MIDDLE EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Abu Dhabi	ADNOC	Ruwais	132,050	0	0	26,730	0	0	0
Abu Dhabi	ADNOC	Umm Al-Nar	80,750	0	0	0	0	0	0
Bahrain	Bahrain Petroleum Co.	Awali	248,900	0	41,400	48,600	3,060	0	0
Cyprus	Cyprus Petroleum Refinery Ltd	Larnaca	26,000	0	0	0	0	0	0
Fujairah	Metro Oil Corporation	Fujairah	35,000	0	0	0	0	0	0
Iran	NIOC	Tehran	225,000	0	0	57,200	0	0	0
Iran	NIOC	Isfahan	265,000	0	0	30,000	0	0	0
Iran	NIOC	Arak	150,000	0	0	24,500	0	0	0
Iran	NIOC	Tabriz	112,000	0	0	18,000	0	0	0
Iran	NIOC	Shiraz	40,000	0	0	9,280	0	0	0
Iran	NIOC	Abadan	400,000	0	30,000	0	0	0	0
Iran	NIOC	Lavan	20,000	0	0	0	0	0	0
Iran	NIOC	Kermanshah (Bakhtaran)	30,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Baiji, North	150,000	0	0	38,000	0	4,000	0
Iraq	Ministry of Oil	Dorah	92,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Basrah	126,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Haditha	7,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Khanaqin	12,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Nassiriyah	27,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Qayyarah	12,500	0	0	0	0	0	0
Iraq	Ministry of Oil	Kirkuk	27,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Baiji, Sulahuddin	140,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Al Jezira	20,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Al Syniya	20,000	0	0	0	0	0	0
Iraq	Ministry of Oil	Kasek	20,000	0	0	0	0	0	0
Israel	Oil Refineries	Haifa	130,000	0	22,000	0	0	5,000	0
Israel	Oil Refineries	Ashdod	90,000	0	27,500	0	0	0	0

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TABLE 4.6-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, MIDDLE EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro cracking	Alkylation	Aromatics	Isom
Jordan	Jordan Petroleum Refinery	Zarqa	100,000	0	4,350	4,230	0	0	0
Kuwait	KNPC	Shuaiba	154,000	0	0	82,000	0	0	0
Kuwait	KNPC	Mina Abdulla	255,000	60,000	0	38,000	0	0	0
Kuwait	KNPC	Mina Al-Ahmadi	415,000	0	28,000	36,000	0	0	0
Neutral Zone	Arabian Oil CL	Al Khafji	30,000	0	0	0	0	0	0
Oman	Oman Refinery Co.	Mina Al Fahal	85,000	0	0	0	0	0	0
Qatar	QGPC	Umm Saeed	57,500	0	0	0	0	0	0
Saudi Arabia	Arabian Oil Co. Ltd.	Ras Al Khafji	30,000	0	0	0	0	0	0
Saudi Arabia	Jeddah Refining Company	Jeddah	82,000	0	13,000	10,000	0	0	0
Saudi Arabia	Saudi Aramco	Riyadh	140,000	0	0	33,820	0	*0*	0
Saudi Arabia	Saudi Aramco	Ras Tanura	300,000	0	0	0	0	0	0
Saudi Arabia	Saudi Aramco	Yanbu	190,000	0	0	0	0	0	0
Saudi Arabia	Saudi Aramco	Rabigh	290,000	0	0	0	0	0	0
Saudi Arabia	Saudi Aramco-Mobil	Yanbu	331,700	0	90,600	40,000	23,500	0	0
Saudi Arabia	Saudi Aramco-Shell	Jubail	292,000	0	0	44,000	0	5,800	0
Syria	Banias Refining Co.	Banias	135,000	0	0	25,000	0	0	0
Syria	Homs Refinery Co.	Homs	110,890	20,150	0	0	0	0	525
Yemen	Aden Refinery Co.	Aden	110,000	0	0	0	0	0	0
Yemen	Ministry of Oil	Marib	10,000	0	0	0	0	0	0
		Total	**5,756,290**	**80,150**	**256,850**	**565,360**	**26,560**	**14,800**	**525**

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TABLE 4.6-2
REGIONAL REFINERY CAPACITY, MIDDLE EAST- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Saudi Arabia	Saudi Aramco-Mobil	Yanbu	331,700	0	90,600	0	23,500	0	0
Saudi Arabia	Saudi Aramco-Shell	Jubail	292,000	0	0	44,000	0	5,800	0
		Total	**623,700**	**0**	**90,600**	**44,000**	**23,500**	**5,800**	**0**

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TABLE 4.7-1
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Australia	Ampol	Kurnell	109,250	0	46,000	0	7,800	0	0
Australia	Ampol	Lytton	95,000	0	32,000	0	3,300	0	0
Australia	Australian Lubricating Oil Refinery Ltd.	Kurnell	0	0	0	0	0	0	0
Australia	BP Australia	Bulwer Island	69,350	0	18,000	0	1,890	0	0
Australia	BP Australia	Kwinana	131,575	0	27,900	0	2,430	0	0
Australia	Inland Oil Refiners	Eromanga	1,500	0	0	0	0	0	0
Australia	Mobil Oil Australia Ltd.	Adelaide (Port Stanvac)	68,400	0	0	0	0	0	0
Australia	Mobil Oil Australia Ltd.	Altona	102,600	0	23,000	0	2,500	0	0
Australia	Shell Refining (Australia) PL	Clyde	81,700	0	35,000	0	3,000	0	0
Australia	Shell Refining (Australia) PL	Geelong	104,500	0	38,000	0	4,500	0	0
Bangladesh	Eastern Refinery Ltd.	Chittagong	31,200	0	0	1,180	0	0	0
Brunei	Brunei Shell Petroleum CL	Seria	8,600	0	0	0	0	0	0
Burma	Myanmar Petrochemical Enterprise	Chauk	6,000	0	0	0	0	0	0
Burma	Myanmar Petrochemical Enterprise	Thanlyin (Mann)	26,000	5,200	0	0	0	0	0
China	Anqing Petrochemical	Anqing	60,247	8,000	24,000	0	1,000	0	0
China	Anshan Petrochemical	Anshan	50,205	0	24,000	0	0	0	0
China	Asphalt Plant of Liaohe Oil Field	Panjin	30,123	0	0	0	0	0	0
China	Baling Petrochemical	Baling	100,411	12,000	50,000	9,000	2,000	0	0
China	Baoding Petrochemical	Boading	8,033	0	0	0	0	0	0
China	Cangzhou Oil Refining	Cangzhou	24,099	0	9,000	0	0	0	0
China	Dagang Refinery	Dagang	20,082	0	0	0	0	0	0
China	Dalian Petrochemical	Dalian	142,584	0	70,000	20,000	2,000	0	0
China	Daqing Chemical Plant	Daqing	6,025	0	0	0	0	0	0
China	Daqing Petrochemical	Daqing	110,452	13,000	14,000	8,000	1,000	1,500	0
China	Duzishan Refining	Duzishan	66,000	8,000	12,000	8,000	0	0	0
China	Fujian Oil Refining	Fujian	50,205	10,000	16,000	0	0	0	0
China	Fushun Petrochemical	Fushun	174,715	35,000	66,000	8,000	3,000	0	0
China	Golmud Refinery	Qinhau	20,082	0	0	0	0	0	0
China	Guangzhou Petrochemical	Guangzhou	104,000	0	44,000	0	1,000	0	0
China	Hangzhou Refinery	Hangzhou	3,213	0	0	0	0	0	0

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TABLE 4.7-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
China	Harbin Refinery	Harbin	30,123	0	6,000	0	0	0	0
China	Huabei Chemical Pharmaceutical Plant	Shijiazhuang	4,016	0	0	0	0	0	0
China	Jianghan Petrochemical Plant	Qianjiang	2,410	0	0	0	0	0	0
China	Jiangnan Refinery	Jilin	6,025	0	0	0	0	0	0
China	Jilin Refinery	Qiangou	3,012	0	0	0	0	0	0
China	Jinan Oil Refining	Jinan	60,247	0	22,000	0	0	0	0
China	Jingmen Oil Refining	Jingmen	100,411	8,000	20,000	8,000	0	0	0
China	Jinling Petrochemical	Jinling	134,000	12,000	44,000	16,600	1,000	0	0
China	Jinxi Chemical	Jinxi	100,411	0	24,000	0	1,200	0	0
China	Jinzhou Petrochemical	Jinzhou	110,452	20,000	16,000	0	0	0	0
China	Jiujiang Oil Refining	Jiujiang	50,205	0	24,000	8,000	0	0	0
China	Karamay Refinery	Karamay	33,136	0	0	0	0	0	0
China	Lanzhou Chemical Industry Corp.	Lanzhou	17,000	0	0	0	0	0	0
China	Lanzhou Refining	Lanzhou	100,411	0	24,000	0	1,000	0	0
China	Liaoyang Chemical Fiber Corp.	Liaoyang	56,300	0	24,000	0	0	*1,400*	0
China	Linyuan Refinery	Linyuan	30,123	0	17,000	0	0	0	0
China	Luoyang Oil Refining	Luoyang	104,427	0	40,000	0	2,000	0	0
China	Majiatan Refinery	Lingwu	2,008	0	0	0	0	0	0
China	Maling Refinery	Qingyang	6,025	0	0	0	0	0	0
China	Maoming Petrochemical	Maoming	170,699	12,000	32,000	16,000	1,000	1,000	0
China	Mudanjiang Dongfanghong Refinery	Mudanjiang	4,016	0	0	0	0	0	0
China	Nanchong Refinery	Nanchong	3,012	0	0	0	0	0	0
China	Qianguo Oil Refining	Qianguo	30,123	0	24,000	0	0	0	0
China	Qilu Petrochemical	Qilu	160,658	16,000	46,000	42,000	3,000	0	0
China	Qingdao Petrochemical Plant	Qingdao	13,053	0	0	0	0	0	0
China	Henan Oil Administration	Nanyang	2,410	0	0	0	0	0	0
China	Jilin Petrochemical Co.	Jilin	86,353	0	0	0	0	0	0
China	Shanghai Gaoqiao Petrochemical	Shanghai Gaoqiao	146,000	10,000	38,000	0	1,000	0	0
China	Shanghai Petrochemical	Jinshan	106,436	0	0	18,000	2,400	4,400	0
China	Shengli Heavy Oil Plant	Dongying	20,082	0	0	0	0	0	0

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TABLE 4.7-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
China	Shengli Refinery	Dongying	3,012	0	0	0	0	0	0
China	Shijia Oil Refining	Shijiazhuang	70,000	10,000	24,000	0	1,000	0	0
China	Shongyuan Refinery	Puyang	3,012	0	0	0	0	0	0
China	Tianjin Petrochemical	Tianjin	74,000	0	35,000	0	1,000	2,000	0
China	Tianyang Refinery	Tianyang	1,004	0	0	0	0	0	0
China	Urumqi General Petrochemical	Wulumuqi	50,205	8,000	16,000	0	0	0	0
China	West Pacific Petrochemical	Dalian	95,000	0	37,800	0	2,250	0	0
China	Wuhan Oil Refining	Wuhan	50,205	0	20,000	0	1,000	0	0
China	Yanchang Oil & Mineral	Yanchang	14,058	0	0	0	0	0	0
China	Yangzi Petrochemical	Yangzi	60,247	0	21,000	24,000	0	0	0
China	Yanshan Petrochemical	Yanshan	140,575	0	48,000	0	1,000	0	0
China	Yumen Refinery	Yumen	30,123	0	0	0	0	0	0
China	Zepu Petrochemical Plant	Zepu	3,012	0	0	0	0	0	0
China	Zhenhai Petrochemical	Zhenhai	140,575	8,000	28,200	0	1,000	0	0
India	Bharat Petroleum CL	Mahul Bombay	134,860	0	28,755	0	0	13,000	0
India	Bongaigaon Refinery	Bongaigaon Assam	27,110	9,675	0	0	0	694	0
India	Cochin Refineries Ltd.	Cochin	151,000	0	27,000	0	0	12,000	0
India	Hindustan Petroleum CL	Mahul Bombay	110,452	0	12,000	0	0	0	0
India	Hindustan Petroleum CL	Mangalore	60,000	0	0	18,900	0	0	0
India	Hindustan Petroleum CL	Visakhapatnam	90,369	0	19,200	0	0	0	0
India	IBP CL	Numaligarh	123,500	0	0	0	0	0	0
India	Indian Oil CL	Barauni	65,800	20,000	0	0	0	0	0
India	Indian Oil CL	Digboi	11,700	850	0	0	0	0	0
India	Indian Oil CL	Gawahati	19,920	6,000	0	0	0	0	0
India	Indian Oil CL	Haldia	61,000	0	0	0	0	0	0
India	Indian Oil CL	Koyali	185,100	0	20,000	25,000	0	6,000	0
India	Indian Oil CL	Mathura	156,000	0	20,000	0	0	0	0
India	Madras Refineries Ltd.	Madras	130,660	0	11,250	0	0	0	0

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TABLE 4.7-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Indonesia	Pertamina	Balikpapan	240,920	0	0	49,500	0	0	0
Indonesia	Pertamina	Balongan (EXOR-I)	125,000	0	83,000	0	0	0	0
Indonesia	Pertamina	Cepu	3,420	0	0	0	0	0	0
Indonesia	Pertamina	Cilacap	285,000	0	0	0	0	0	0
Indonesia	Pertamina	Dumai	114,000	32,580	0	50,220	0	0	0
Indonesia	Pertamina	Musi	133,600	0	18,450	0	16,200	0	0
Indonesia	Pertamina	Pangakalan Brandan	4,750	0	0	0	0	0	0
Indonesia	Pertamina	Sungaipakning	47,500	0	0	0	0	0	0
Indonesia	Pertamina	Wonokomo	3,000	0	0	0	0	0	0
Japan	Cosmo Oil CL	Chiba	228,000	0	31,500	0	0	0	0
Japan	Cosmo Oil CL	Sakai	104,500	0	19,800	0	7,200	0	0
Japan	Cosmo Oil CL	Yokkaichi City	147,250	0	22,500	0	0	0	0
Japan	Cosmo Oil CL	Sakaide	133,000	0	17,100	0	0	0	0
Japan	Fuji Oil CL	Sodegaura	153,900	0	13,950	21,600	0	7,402	0
Japan	General Sekiyu Seisei KK	Sakai	140,400	0	36,000	0	0	19,800	0
Japan	Idemitsu Kosan CL	Chita, Aichi	152,000	0	56,000	0	9,000	0	0
Japan	Idemitsu Kosan CL	Himeji	133,000	0	0	0	0	0	0
Japan	Idemitsu Kosan CL	Ichihara, Chiba	237,500	0	37,800	10,440	0	12,060	0
Japan	Idemitsu Kosan CL	Tokuyama	114,000	0	22,500	0	0	0	0
Japan	Idemitsu Kosan CL	Tomakomai	123,500	0	23,400	13,500	0	0	0
Japan	Japan Energy	Chita	86,000	0	15,300	0	0	15,300	0
Japan	Japan Energy	Funakawa	6,000	0	0	0	0	0	0
Japan	Japan Energy	Mizushima	171,000	20,800	34,400	0	7,200	0	0
Japan	Kainan Petroleum Refining CL	Kaiwan City	50,000	0	0	0	0	0	0
Japan	Kashima Oil CL	Kashima	171,000	0	24,300	0	0	2,900	0
Japan	Koa Oil CL	Marifu	127,000	19,000	22,000	0	0	7,500	0
Japan	Koa Oil CL	Osaka	104,000	0	25,000	0	4,000	2,100	0
Japan	Kyenus Sekiyu Seisei KK	Kawasaki	66,500	0	0	0	0	0	0
Japan	Kyokuto Petroleum Ltd.	Chiba	143,000	0	28,000	35,000	0	0	0
Japan	Kyushu Oil CL	Oita	130,000	0	16,500	11,000	0	0	0

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TABLE 4.7-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Japan	Mitsubishi Oil CL	Kawasaki	75,000	0	0	0	0	0	0
Japan	Mitsubishi Oil CL	Mizushima	250,000	0	60,000	11,000	7,600	12,800	0
Japan	Nansei Sekiyu KK	Nishihara	100,000	0	0	0	0	0	0
Japan	Nihonkai Oil CL	Toyama	60,000	0	0	0	0	0	0
Japan	Nippon Oil CL	Niigata	24,700	0	4,500	0	0	0	0
Japan	NPRC	Muroran	161,500	0	20,700	36,000	0	0	0
Japan	NPRC	Negishi	365,750	0	63,900	0	3,960	0	0
Japan	Nippon Petroleum Refining CL	Nakagusuku	0	0	0	0	0	0	0
Japan	Nippon Petroleum Refining CL	Yokohama (Dismantled)	0	0	0	0	0	0	0
Japan	Nippon Refining	Kudamatsu	0	0	0	0	0	0	0
Japan	Okinawa Sekiyu Seisei	Yonashiro	110,000	0	0	0	0	0	0
Japan	Seibu Oil CL	Yamaguchi	114,000	0	19,800	0	0	0	0
Japan	Showa Shell Sekiyu KK	Kawasaki	110,100	0	0	0	0	3,300	0
Japan	Showa Shell Sekiyu KK	Niigata	36,700	0	0	0	0	0	0
Japan	Showa Yokkaichi Sekiyu CL	Yokkaichi	220,300	0	22,600	0	0	5,500	0
Japan	Taiyo Oil CL	Ehime	84,550	0	0	16,200	0	11,800	0
Japan	Teiseki Topping Plant	Kubiki	4,190	0	0	0	0	0	0
Japan	Toa Oil CL	Kawasaki	61,750	21,600	27,000	0	0	0	0
Japan	Toho Oil CL	Owase	35,000	0	0	0	0	0	0
Japan	Tohoku Oil CL	Sendai	83,900	0	25,000	0	0	0	0
Japan	Tonen	Kawasaki	217,350	0	79,380	0	6,615	0	0
Japan	Tonen	Wakayama	156,870	0	34,020	0	2,079	0	0
Korea N.	Government	Paengma-ri	29,000	0	0	0	0	0	0
Korea N.	Government	Sonbong	42,000	0	0	0	0	1,000	0
Korea S.	Hanhwa	Inchon	261,250	0	0	0	0	18,000	0
Korea S.	Hyundai	Busan	0	0	0	0	0	0	0
Korea S.	Hyundai Oil Ref Co.	Daesan	294,500	19,000	0	22,000	0	0	0
Korea S.	LG-Caltex	Yosu	570,000	0	63,000	0	0	20,700	0
Korea S.	Ssangyong Oil Refining CL	Onsan	418,950	0	0	27,000	0	9,600	0
Korea S.	Yukong Ltd.	Ulsan	769,500	0	45,000	27,000	5,400	27,900	0

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TABLE 4.7-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Malaysia	Esso Malaysia	Port Dickson	80,000	0	0	0	0	0	0
Malaysia	Petronas	Melaka	100,000	0	0	0	0	0	0
Malaysia	Petronas	Kerteh	75,000	0	0	0	0	0	0
Malaysia	Sarawak Shell Berhad	Luton	45,000	0	0	0	0	0	0
Malaysia	Shell Refining Co. Berhad	Port Dickson	105,000	0	0	0	0	0	0
New Zealand	New Zealand Refining	Whangarei	91,200	0	0	24,300	0	0	0
Pakistan	Attock Refinery Ltd.	Rawalpindi	28,975	0	0	0	0	0	0
Pakistan	National Refinery Ltd.	Karachi	62,050	0	0	0	0	0	0
Pakistan	Pakistan Refinery Ltd.	Karachi	46,300	0	0	0	0	0	0
Philippines	Caltex (Philippines) Inc.	Batangas	72,000	0	12,500	0	0	0	0
Philippines	Petron Corp.	Limay	147,250	0	13,500	0	0	0	0
Philippines	Pilipinas Shell Petroleum	Tabangao	154,000	0	0	0	0	0	0
Philippines	Philippine Petroleum Corp.	Pililla	0	0	0	0	0	0	0
Singapore	BP Refinery Singapore PL	Pasir Panjang	0	0	0	0	0	0	0
Singapore	Esso Singapore PL	Pulau Ayer Chawan	227,000	0	0	4,400	0	0	0
Singapore	Mobil Oil Singapore PL	Jurong	255,000	0	0	26,000	0	15,000	0
Singapore	Shell Eastern Petroleum Ltd.	Pulau Bukom	405,000	0	28,600	28,600	3,000	0	0
Singapore	Singapore Refining Co. Pte. Ltd.	Pulau Merlimau	270,000	0	31,000	30,300	4,200	0	0
Sri Lanka	Ceylon Petroleum Corp.	Sapugaskanda	47,500	0	0	0	0	0	0
Taiwan	Chinese Petroleum Corp.	Kaohsiung	570,000	16,000	50,000	18,080	3,200	60,000	0
Taiwan	Chinese Petroleum Corp.	Taoyuan	200,000	0	0	0	0	0	0
Thailand	Bangchak Petroleum	Bangkok	120,000	0	0	0	0	0	0
Thailand	Esso Standard Thailand Ltd.	Sriracha	166,000	0	27,000	0	0	0	0
Thailand	Fang Refining	Fang	1,700	0	0	0	0	0	0
Thailand	Rayong Refining	Rayong	145,000	0	0	40,000	0	0	0
Thailand	Star Petroleum	Map Ta Phut	123,500	0	33,300	0	0	0	0
Thailand	Thai Oil CL	Sriracha	207,000	0	11,200	19,900	0	0	0
Thailand	Thai Petrochemical Co.	Rayong	65,000	0	0	0	0	0	0
		TOTAL	**17,707,312**	**360,705**	**2,537,605**	**752,720**	**134,924**	**294,656**	**0**

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TABLE 4.7-2
REGIONAL REFINERY CAPACITY, FAR EAST- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Australia	Mobil Oil Australia Ltd.	Adelaide (Port Stanvac)	68,400	0	0	0	0	0	0
Australia	Mobil Oil Australia Ltd.	Altona	102,600	0	23,000	0	2,500	0	0
Australia	Shell Refining (Australia) PL	Clyde	81,700	0	35,000	0	3,000	0	0
Australia	Shell Refining (Australia) PL	Geelong	104,500	0	38,000	0	4,500	0	0
Japan	Showa Shell Sekiyu KK	Kawasaki	110,100	0	0	0	0	3,300	0
Japan	Showa Shell Sekiyu KK	Niigata	36,700	0	0	0	0	0	0
Korea S.	LG-Caltex	Yosu	570,000	0	63,000	0	0	20,700	0
Malaysia	Esso Malaysia	Port Dickson	80,000	0	0	0	0	0	0
Malaysia	Shell Refining Co. Berhad	Port Dickson	105,000	0	0	0	0	0	0
Philippines	Caltex (Philippines) Inc.	Batangas	72,000	0	12,500	0	0	0	0
Singapore	Esso Singapore PL	Pulau Ayer Chawan	227,000	0	0	4,400	0	0	0
Singapore	Mobil Oil Singapore PL	Jurong	255,000	0	0	26,000	0	15,000	0
Singapore	Shell Eastern Petroleum Ltd.	Pulau Bukom	405,000	0	28,600	28,600	3,000	0	0
Thailand	Esso Standard Thailand Ltd.	Sriracha	166,000	0	27,000	0	0	0	0
Thailand	Rayong Refining	Rayong	145,000	0	0	40,000	0	0	0
Thailand	Star Petroleum	Map Ta Phut	123,500	0	33,300	0	0	0	0
		TOTAL	**2,652,500**	**0**	**260,400**	**99,000**	**13,000**	**39,000**	**0**

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TABLE 4.8-1
REGIONAL REFINERY CAPACITY, OTHER US
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
ARCO	Kuparuk	AK	12,000	0	0	0	0	0	0
ARCO	Prudhoe Bay	AK	15,000	0	0	0	0	0	0
Mapco Petroleum	North Pole	AK	130,000	0	0	0	0	2,500	0
Petro Star Inc.	North Pole	AK	14,000	0	0	0	0	0	0
Petro Star Inc.	Valdez	AK	40,000	0	0	0	0	0	0
Tesoro Petroleum	Kenai	AK	72,000	0	0	9,000	0	0	0
Berry Petroleum Co.	Stevens	AR	6,700	0	0	0	0	0	0
Cross Oil	Smackover	AR	6,000	0	0	0	0	0	0
Lion Oil Co.	El Dorado	AR	52,500	0	19,100	0	5,000	0	0
Conoco	Denver/Commerce City	CO	57,500	0	19,000	0	0	0	0
Total Petroleum	Commerce City/Denver	CO	28,000	0	8,000	0	0	0	0
Star Enterprise	Delaware City	DE	140,000	41,850	63,000	17,100	8,190	1,260	0
CITGO	Savannah	GA	28,000	0	0	0	0	0	0
Young Refining	Douglasville	GA	6,000	0	0	0	0	0	0
BHP Hawaii Inc.	Ewa Beach/Kapolei	HA	95,000	0	0	18,000	0	0	0
Chevron	Barbers Point	HA	54,000	0	21,000	0	4,000	0	0
Clark Oil	Blue Island	IL	66,500	0	23,800	8,500	5,700	*0*	0
Clark Oil	Hartford	IL	57,000	13,000	24,700	0	7,600	0	0
Marathon Oil	Robinson	IL	166,000	24,200	43,000	21,000	11,500	0	0
Mobil Oil	Joliet	IL	203,700	43,800	93,500	0	26,300	0	0
Shell Wood River	Wood River	IL	271,000	0	85,000	28,500	20,500	3,500	0
Uno-Ven Co.	Lemont	IL	145,350	25,110	52,200	0	16,200	3,150	0
Amoco Oil	Whiting	IN	410,000	30,400	149,200	0	30,400	14,300	0
Countrymark Cooperative	Mt. Vernon	IN	22,000	0	7,850	0	1,700	0	0
Laketon Refining Corp.	Laketon	IN	3,990	0	0	0	0	0	0
Farmland Industries	Coffeyville	KS	110,000	16,500	28,000	0	7,000	0	0
Natl Coop Ref Assn	McPherson	KS	73,600	20,800	19,800	9,400	5,700	0	0
Texaco	El Dorado	KS	99,750	15,300	31,320	0	10,800	2,700	0
Ashland Petroleum	Catlettsburg	KY	219,300	0	97,000	0	11,640	5,820	0
Somerset Refinery	Somerset	KY	5,500	0	0	0	0	0	0
Lakeside Refining	Kalamazoo	MI	5,600	0	0	0	0	0	0
Marathon Oil	Detroit	MI	70,000	0	27,000	0	4,000	0	0
Total Petroleum	Alma	MI	45,600	0	18,500	0	4,600	0	0

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TABLE 4.8-1 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER US
(Barrels per Stream Day)

Company	Location	State	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Ashland Petroleum	St. Paul Park	MN	69,000	0	22,310	0	5,335	0	0
Koch Refining	Rosemount	MN	286,000	66,000	86,500	0	12,000	0	0
Cenex	Laurel	MT	41,450	0	13,500	0	3,780	0	0
Conoco	Billings	MT	49,400	11,700	17,100	0	5,400	0	0
Exxon	Billings	MT	46,000	7,300	20,000	4,500	3,200	0	0
Montana Refining Co.	Great Falls	MT	7,000	0	2,400	0	700	0	0
Amoco Oil	Mandan	ND	58,000	0	24,700	0	4,200	0	0
Amerada-Hess	Port Reading	NJ	0	0	54,000	0	4,050	0	0
Chevron	Perth Amboy	NJ	80,000	0	0	0	0	0	0
CITGO	Thorofare	NJ	80,000	0	0	0	0	0	0
Coastal Ref. & Mkt.	Westville	NJ	125,000	0	50,000	0	3,500	6,500	0
Mobil Oil	Paulsboro	NJ	149,000	22,600	43,700	0	10,300	0	0
Tosco	Linden	NJ	240,000	0	135,000	0	12,000	0	0
Petrosource *	Tonopah/Eagle Springs	NV	7,000	0	0	0	0	0	0
Ashland Petroleum	Canton	OH	65,900	0	24,250	0	6,790	0	0
BP Oil Co.	Lima	OH	161,500	18,900	33,300	21,600	6,500	4,950	0
BP Oil Co.	Toledo	OH	147,250	18,900	54,000	25,200	10,350	0	0
Sun Refining & Mkt.	Toledo	OH	125,000	0	62,000	28,200	9,000	9,000	0
Conoco	Ponca City	OK	155,000	21,500	53,000	0	12,000	0	0
Gary-Williams Energy Corp.	Wynnewood	OK	45,000	0	17,500	4,500	4,500	0	0
Sinclair Oil	Tulsa	OK	50,000	0	16,200	0	2,700	0	0
Sun Refining & Mkt.	Tulsa	OK	85,000	7,200	0	0	0	0	0
Total Petroleum	Ardmore	OK	68,000	0	23,000	0	6,200	0	0
Pennzoil Products	Rouseville	PA	15,700	0	0	0	0	0	0
Sun Refining & Mkt.	Marcus Hook	PA	175,000	0	87,000	0	10,000	19,200	0
Sun Refining & Mkt.	Philadelphia-Girard Pt.	PA	177,000	0	59,500	0	16,700	3,700	0
Sun Refining & Mkt.	Philadelphia-Pt. Breeze	PA	130,000	0	36,000	27,000	5,400	0	0
Tosco	Marcus Hook	PA	180,500	0	47,700	18,900	10,800	0	0
United Refining Co.	Warren	PA	66,700	0	23,000	0	3,500	0	0
Witco Chemical Co.	Bradford	PA	10,000	0	0	0	0	0	0
Mapco Petroleum	Memphis	TN	105,000	0	50,000	0	6,000	0	0
Crysen Refining	Woods Cross	UT	12,500	0	0	4,000	0	0	0
Phillips Petroleum Co.	Woods Cross	UT	25,000	0	7,700	0	2,200	0	0
Amoco Oil	Yorktown	VA	56,700	18,000	25,700	0	0	0	0
		TOTAL	**5,543,190**	**423,060**	**1,920,030**	**236,400**	**357,935**	**74,080**	**0**

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TABLE 4.8-2
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Africa									
Algeria	NAFTEC	Skikida	310,000	0	0	0	0	4,500	0
Algeria	NAFTEC	Arzew	60,000	0	0	0	0	0	0
Algeria	NAFTEC	Hassi Messoud	30,000	0	0	0	0	0	0
Algeria	NAFTEC	El-Marrach	58,000	0	0	0	0	0	0
Algeria	NAFTEC	In Amenas	7,000	0	0	0	0	0	0
Angola	Cabinda Gulf Oil Co.	Cabinda	1,400	0	0	0	0	0	0
Angola	Fina	Luanda	32,100	0	0	0	0	0	0
Cameroon	Sonara-National Refining CL	Pointe Limboh Limbe	42,000	0	0	0	0	0	0
Congo	Coraf	Pointe-Noire	21,000	0	0	2,000	0	0	0
Cote d'Ivoire	Ste. Ivoirienne de Raffinage	Abidjan	54,000	0	0	13,000	0	0	0
Cote d'Ivoire	Ste. Multinationale de Bitumes	Abidjan	10,000	0	0	0	0	0	0
Egypt	Alexandria Petroleum Co.	Alexandria (El-Mex)	94,860	0	0	0	0	603	0
Egypt	Ameriya Petroleum Company	Ameriya	68,620	0	0	0	9,000	700	0
Egypt	Cairo Petroleum Company	Mostorod	141,160	0	0	0	0	0	0
Egypt	Cairo Petroleum Company	Tanta	29,000	0	0	0	0	0	0
Egypt	El-Nasr Petroleum Co.	Suez	99,300	0	0	0	0	0	0
Egypt	El-Nasr Petroleum Co.	Wadi-Feran	7,060	0	0	0	0	0	0
Egypt	El-Nasr Petroleum Co.	Asyut	43,540	0	0	0	0	0	0
Egypt	Suez Petroleum Company	Suez	62,520	16,470	0	0	0	0	0
Ethiopia	Ethiopian Petroleum Corp.	Assab	18,000	0	0	0	0	0	0
Gabon	Ste. Gabonaise de Raffinage	Port Gentil	17,300	0	0	0	0	0	0
Ghana	Ghanaian Italian Petroleum CL	Tema	26,600	0	0	0	0	0	0
Kenya	Kenya Petroleum Refineries Ltd.	Mombasa	85,500	0	0	0	0	0	0
Liberia	Liberia Petroleum Refining	Monrovia	0	0	0	0	0	0	0
Libya	NOC	Sarir	10,000	0	0	0	0	0	0
Libya	NOC	Azzawiya	120,000	0	0	0	0	0	0
Libya	NOC	Mersa El-Brega	8,400	0	0	0	0	0	0
Libya	NOC	Ras Lanuf	220,000	0	0	0	0	0	0
Libya	NOC	Tobruk	20,000	0	0	0	0	0	0
Libya	NOC	Sebha	0	0	0	0	0	0	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Madagascar	Solima	Tamatave Solima	15,000	0	0	0	0	0	0
Mauritania	SAMIR	Nouadhibou	23,750	0	0	0	0	0	0
Morocco	SAMIR	Mohammadia	129,000	0	0	0	0	0	0
Morocco	Ste. Cherifienne des Petroles	Sidi Kacem	26,600	0	5,040	0	0	0	0
Nigeria	Nigerian Petroleum Refining CL	Port Harcourt (Rivers State)	150,000	0	40,000	0	7,020	0	0
Nigeria	Nigerian Petroleum Refining CL	Warri	118,750	0	24,700	0	2,850	0	0
Nigeria	Nigerian Petroleum Refining CL	Kaduna	104,500	0	18,000	0	0	0	0
Nigeria	Nigerian Petroleum Refining CL	Port Harcourt (Alesa Eleme)	60,000	0	0	0	0	0	0
Senegal	Ste. Africaine de Raffinage	M'Bao (Dakar)	17,000	0	0	0	0	0	0
Sierra Leone	Sierra Leone Petroleum Refining Co.	Freetown	10,000	0	0	0	0	0	0
Somalia	Iraqsoma Ref. Co.	Mogadishu	10,000	0	0	0	0	0	0
South Africa	Caltex Oil SA PL	Cape Town	106,400	0	22,500	0	0	0	0
South Africa	Genref	Durban	85,000	0	15,000	0	2,200	0	0
South Africa	National Petroleum Refiners of South Africa PL	Sasolburg OFS	86,000	0	18,000	23,500	3,300	0	0
South Africa	Shell and BP South Africa Petroleum Refineries PL	Durban	156,750	0	31,500	0	2,700	*0*	0
South Africa	South African Oil Refinery (Pty.) Limited	Durban	0	0	0	0	0	0	0
Sudan	Concorp	Abu Gabra	2,000	0	0	0	0	0	0
Sudan	GEPCO	Port Sudan	21,700	0	0	0	0	0	0
Tanzania	Tanzanian & Italian Petroleum Refining CL	Kigamboni Dar es Salaam	15,865	0	0	0	0	0	0
Tunisia	STIR	Bizerte	34,000	0	0	0	0	0	0
Zaire	Sozir	Kinlao-Muanda	17,000	0	0	0	0	0	0
Zambia	Indeni Petroleum Refinery CL	Ndola	23,750	0	0	0	0	0	0
Zimbabwe	Central African Petroleum Refineries (Pty.) Limit.	Mutare (Closed 1985)	0	0	0	0	0	0	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Canada									
Canada	Chevron Canada Ltd.	North Burnaby	50,000	0	18,000	0	3,000	0	0
Canada	Consumers' Cooperative Refineries Ltd.	Regina	45,200	8,300	17,600	10,800	0	0	0
Canada	Husky Oil Operations Ltd.	Lloydminster	23,500	0	0	0	0	0	0
Canada	Husky Oil Operations Ltd.	Prince George	9,500	0	3,300	0	0	0	0
Canada	Imperial Oil Ltd.	Dartmouth	84,360	0	28,500	0	0	0	0
Canada	Imperial Oil Ltd.	Edmonton	176,000	0	50,000	0	16,000	0	0
Canada	Imperial Oil Ltd.	Ioco	0	0	0	0	0	0	0
Canada	Imperial Oil Ltd.	Nanticoke	112,000	0	40,850	0	11,000	0	0
Canada	Imperial Oil Ltd.	Norman Wells	0	0	0	0	0	0	0
Canada	Imperial Oil Ltd.	Sarnia	119,000	23,300	25,650	13,000	7,400	5,000	0
Canada	Irving Oil Ltd.	St. John	237,500	0	24,000	29,700	5,000	0	0
Canada	North Atlantic Refining Ltd.	Come By Chance	99,750	0	0	31,500	0	0	0
Canada	Novacor Chemicals (Canada) Ltd.	Corunna	80,000	0	0	0	0	10,200	0
Canada	Parkland Refining Ltd.	Bowden	6,000	0	0	0	0	0	0
Canada	Petro-Canada Products Inc.	Edmonton	119,000	7,500	34,300	18,700	12,600	0	0
Canada	Petro-Canada Products Inc.	Mississauga	0	0	0	10,300	0	0	0
Canada	Petro-Canada Products Inc.	Montreal	92,500	0	18,400	20,900	2,700	8,350	0
Canada	Petro-Canada Products Inc.	Oakville	80,500	0	25,400	0	3,300	0	0
Canada	Petro-Canada Products Inc.	Port Moody	0	0	0	0	0	0	0
Canada	Petro-Canada Products Inc.	Taylor	0	0	0	0	0	0	0
Canada	Saskoil	Moose Jaw	12,000	0	0	0	0	0	0
Canada	Shell Canada Ltd.	Burnaby	0	0	0	0	0	0	0
Canada	Shell Canada Ltd.	Montreal	125,500	0	24,000	11,700	2,500	0	0
Canada	Shell Canada Ltd.	Sarnia	71,400	0	14,400	6,750	0	2,700	0
Canada	Shell Canada Ltd.	Scotford	75,700	0	0	40,500	0	5,300	0
Canada	Suncor Inc.	Sarnia	83,400	0	15,500	23,700	5,600	9,500	0
Canada	Turbo Resources Ltd.	Balzac	0	0	0	0	0	0	0
Canada	Ultramar	Halifax	0	0	0	0	0	0	0
Canada	Ultramar Canada Inc.	St. Romuald	150,000	0	47,000	0	0	0	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Eastern Europe									
Albania	Government	Balish	20,000	0	0	0	0	0	0
Albania	Government	Fier	10,000	0	0	0	0	0	0
Albania	Government	Cerrik	10,000	0	0	0	0	0	0
Albania	Government	Kucove (Stalin)	10,000	0	0	0	0	0	0
Bosnia	Energoinvest Sarajevo (Destroyed by War)	Slavonski Brod (Bosanski)	0	0	0	0	0	0	0
Bulgaria	Government	Rest of Country	0	0	0	0	0	0	0
Bulgaria	Government-Owned Refineries	Ruse	2,000	0	0	0	0	0	0
Bulgaria	Neftochim	Bourgas	240,000	0	32,000	0	0	3,500	0
Bulgaria	PLAMA	Pleven	30,000	0	0	0	0	0	0
Croatia	INA-Rafinerija Nafte Rijeka	Rijeka	150,000	0	22,000	0	0	3,300	0
Croatia	INA-Rafinerija Nafte Sisak	Sisak	143,472	5,930	10,000	0	0	9,979	0
Croatia	Zagreg Refinery	Zagreb	803	0	0	0	0	0	0
Czech Republic	Chempetrol	Litvinov	100,000	0	0	22,000	0	5,000	0
Czech Republic	Kaucuk s.p.	Kralupy	66,850	0	0	0	0	0	0
Czech Republic	Koramo	Kolin	0	0	0	0	0	0	0
Czech Republic	Paramo	Pardubice	20,289	0	0	0	0	0	0
Czechoslovakia	Government	Rest of Country	0	0	0	0	0	0	0
Hungary	Dunai KV	Szazhalombatta	161,000	0	24,000	0	3,300	7,100	0
Hungary	Tiszai KV	Leninvaros	61,000	0	0	0	0	0	0
Hungary	Zalai KV	Zalaegerszeg	10,000	0	0	0	0	0	0
Lithuania	Mazheiksky NPZ	Mazeikiai	240,000	0	41,063	0	0	0	0
Macedonia	Rafinerija Skopje	Skopje	51,180	0	0	0	0	0	0
Poland	Gdansk Zaklady Rafineryjne	Gdansk	60,000	0	0	0	0	0	0
Poland	Government	Rest of Country	0	0	0	0	0	0	0
Poland	Mazoweckie Zadlady Rafineryjne i Petrochemiczne	Plock (MZRIP)	260,000	0	46,000	0	3,000	3,500	0
Poland	Podkarpackie Zaklady Rafineryjne	Jaslo (Carpathian)	3,000	0	0	0	0	0	0
Poland	Rafineria Jafy Jedlicze	Jedlicze	7,200	0	0	0	0	0	0
Poland	Rafineria Nafy Gilmar	Gorlice (Gilmar)	3,400	0	0	0	0	0	0
Poland	Rafineria Nafy Trzebinin	Trzebina	7,000	0	0	0	0	0	0
Poland	Salaskie Zaklady Rafineryjne	Dziedzice (Silesian)	14,000	0	0	0	0	0	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Eastern Europe									
Romania	Arpechim SA	Pitesti	70,288	0	19,178	1,534	0	1,591	0
Romania	Astra SA	Ploiesti	56,000	8,600	0	0	0	0	0
Romania	Crisiana	Barcau	8,000	0	0	0	0	0	0
Romania	Darmanesti Refinery	Darmanesti	33,000	9,500	0	0	0	0	0
Romania	Lubrifin SA	Brasov	0	0	0	0	0	0	0
Romania	Petrobrazi SA	Ploiesti	159,000	39,000	23,000	0	0	4,000	4,500
Romania	Petromidia SA	Navodari	110,000	20,000	23,700	0	0	4,700	0
Romania	Petrotel SA	Ploiesti	104,000	11,480	20,900	0	2,300	0	0
Romania	Rafo SA	Onesti	87,358	5,638	23,014	0	0	6,803	0
Romania	Steaua SA	Cimpina	9,272	0	0	0	0	0	0
Romania	Vega SA	Ploiesti	18,516	0	0	0	0	0	0
Serbia	Belgrade Lube Refinery	Obrenovac (Belgrade)	1,000	0	0	0	0	0	0
Serbia	Naftgas-Petroleum Industries	Pancevo	108,000	0	21,000	0	2,100	2,904	0
Serbia	Naftgas-Petroleum Industries	Novi Sad	60,246	0	0	0	0	0	0
Slovakia	Petrochemica Dubova	Banska Bystrica	0	0	0	0	0	0	0
Slovakia	Slovnaft	Bratislava	115,000	0	0	16,970	0	3,164	0
Slovakia	Slovnaft	Vojany	0	0	0	0	0	0	0
Slovenia	Lendava Refinery	Lendava	12,000	0	0	0	0	0	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Former Soviet Union									
Azerbaijan	Bakinsky	Bakinsky	238,978	0	0	0	0	0	0
Azerbaijan	Novo-Bakinsky	Bakinsky	202,830	38,529	71,342	0	930	0	0
Belarus	Mozyrsksky NPZ	Mozyr	323,323	0	0	12,000	0	0	0
Belarus	Novopolotsknefteorgsintez	Novopolotsk	401,644	0	0	0	0	5,112	0
Georgia	Batumsky NPZ	Batumi	106,340	0	0	0	0	0	0
Kazakhstan	Chimkentsky NPZ	Chimkent	160,000	0	0	0	0	0	0
Kazakhstan	Gyr'yevsky NPZ	(Guryev) Atyrau	104,427	13,720	0	0	0	0	0
Kazakhstan	Pavlodarsky	Pavlodar	162,666	11,277	38,356	0	0	0	0
Russia	Achinsky NPZ	Achinsk	146,584	0	0	0	0	0	0
Russia	Angarsknefteorgsintez	Angarsk	463,899	11,217	33,753	0	0	3,182	0
Russia	Government	Afipsky	28,115	0	0	0	0	3,680	0
Russia	Government	Novo-Groznyi	0	0	0	0	0	0	0
Russia	Government	Groznyi-Sheripov	40,164	0	0	0	0	0	0
Russia	Government	Ishimbai	0	0	0	0	0	0	0
Russia	Groznefteorgsintez	Grozny	389,595	0	38,356	0	0	0	0
Russia	Khabarovsky NPZ	Khabarovsk	114,468	0	0	0	0	0	0
Russia	Kirishinefteorgsintez	Kirishi	387,586	0	0	0	0	5,172	0
Russia	Komsomol'sky NPZ	Komsomolsk	116,477	9,679	0	0	0	0	0
Russia	Krasnodarnefteorgsintez	Krasnodar	34,140	0	0	0	0	0	0
Russia	Kuibyshevsky NPZ	Kuibyshev	120,493	0	18,795	0	832	0	0
Russia	Lukoil	Astrakhan	66,000	0	24,466	0	0	0	0
Russia	Lukoil	Kondpetroleum	6,000	0	0	0	0	0	0
Russia	Lukoil	Makhachkala	4,000	0	0	0	0	0	0
Russia	Lukoil	Urayneftegaz	2,000	0	0	0	0	0	0
Russia	Moskovsky NPZ	Moscow	242,995	0	38,356	0	0	0	0
Russia	Nizhnekamskneftekhim	Nizhnekamsk	120,493	0	0	0	0	0	0
Russia	Norsi Oil	Norsi	437,792	1,260	0	0	0	1,790	0
Russia	Novokuibyshevsky NPZ	Novo-Kuibyshev	309,266	28,192	13,616	0	0	2,188	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Former Soviet Union									
Azerbaijan	Bakinsky	Bakinsky	238,978	0	0	0	0	0	0
Azerbaijan	Novo-Bakinsky	Bakinsky	202,830	38,529	71,342	0	930	0	0
Belarus	Mozyrsksky NPZ	Mozyr	323,323	0	0	12,000	0	0	0
Belarus	Novopolotsknefteorgsintez	Novopolotsk	401,644	0	0	0	0	5,112	0
Georgia	Batumsky NPZ	Batumi	106,340	0	0	0	0	0	0
Kazakhstan	Chimkentsky NPZ	Chimkent	160,000	0	0	0	0	0	0
Kazakhstan	Gyr'yevsky NPZ	(Guryev) Atyrau	104,427	13,720	0	0	0	0	0
Kazakhstan	Pavlodarsky	Pavlodar	162,666	11,277	38,356	0	0	0	0
Russia	Achinsky NPZ	Achinsk	146,584	0	0	0	0	0	0
Russia	Angarsknefteorgsintez	Angarsk	463,899	11,217	33,753	0	0	3,182	0
Russia	Government	Afipsky	28,115	0	0	0	0	3,680	0
Russia	Government	Novo-Groznyi	0	0	0	0	0	0	0
Russia	Government	Groznyi-Sheripov	40,164	0	0	0	0	0	0
Russia	Government	Ishimbai	0	0	0	0	0	0	0
Russia	Groznefteorgsintez	Grozny	389,595	0	38,356	0	0	0	0
Russia	Khabarovsky NPZ	Khabarovsk	114,468	0	0	0	0	0	0
Russia	Kirishinefteorgsintez	Kirishi	387,586	0	0	0	0	5,172	0
Russia	Komsomol'sky NPZ	Komsomolsk	116,477	9,679	0	0	0	0	0
Russia	Krasnodarnefteorgsintez	Krasnodar	34,140	0	0	0	0	0	0
Russia	Kuibyshevsky NPZ	Kuibyshev	120,493	0	18,795	0	832	0	0
Russia	Lukoil	Astrakhan	66,000	0	24,466	0	0	0	0
Russia	Lukoil	Kondpetroleum	6,000	0	0	0	0	0	0
Russia	Lukoil	Makhachkala	4,000	0	0	0	0	0	0
Russia	Lukoil	Urayneftegaz	2,000	0	0	0	0	0	0
Russia	Moskovsky NPZ	Moscow	242,995	0	38,356	0	0	0	0
Russia	Nizhnekamskneftekhim	Nizhnekamsk	120,493	0	0	0	0	0	0
Russia	Norsi Oil	Norsi	437,792	1,260	0	0	0	1,790	0
Russia	Novokuibyshevsky NPZ	Novo-Kuibyshev	309,266	28,192	13,616	0	0	2,188	0

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TABLE 4.8-2 (CONTINUED)
REGIONAL REFINERY CAPACITY, OTHER
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro-cracking	Alkylation	Aromatics	Isom
Russia	Novoufimsky	Novo-Ufa	379,553	7,142	22,247	0	2,814	0	0
Russia	NPO Grozneftekhim	Tuapse	46,189	0	0	0	0	0	0
Russia	Omsknefteorgsintez	Omsk	566,318	13,908	65,589	19,178	1,272	11,139	0
Russia	Orsknefteorgsintez	Orsk	158,649	0	0	0	1,125	0	0
Russia	Permnefteorgsintez	Perm	279,142	13,532	15,726	0	1,003	3,481	0
Russia	Russian Fuel Co JSC	Kutshui	8,000	0	0	0	0	0	0
Russia	Ryanzansky NPZ	Ryazan	361,479	0	18,219	0	0	4,078	0
Russia	Salavatnefteorgsintez	Salavat	247,011	0	21,096	0	1,174	1,591	0
Russia	Saratovsky NPZ	Saratov (Kreking)	176,723	0	0	0	0	0	0
Russia	Surgutgazprom	Surgut	88,000	0	0	0	0	0	0
Russia	Syzransky NPZ	Syzran	210,863	0	17,068	0	0	0	0
Russia	Ufimsky	Ufaneftekhim	234,962	0	38,356	0	0	0	0
Russia	Ufimsky CPSC	Ufimsky	251,027	0	17,260	19,178	0	10,542	0
Russia	Ukhtinsky NPZ	Ukhta	126,518	0	0	0	0	0	0
Russia	Urengoygazdobycha	Urengoy	9,000	0	0	0	0	0	0
Russia	Volgogradsky NPZ	Volgograd	188,733	24,809	0	0	0	1,830	0
Russia	Yakutgazprom	Yakutsk	2,500	0	0	0	0	0	0
Russia	Yaraslav-Mendeleev	Yaraslav	8,700	0	0	0	0	0	0
Russia	Yaroslavl'nefteorgsintez	Yaroslavnette	359,471	0	21,096	0	1,786	1,551	0
Turkmenistan	Charjousky NPZ	Chardzhou	120,493	0	0	0	0	0	0
Turkmenistan	Krasnovodsky NPZ	Krasnovodsk	116,477	28,568	15,151	0	1,028	0	0
Ukraine	Drogobychsky NPZ	Drogobych	78,321	3,195	0	0	0	0	0
Ukraine	Khersonsky NPZ	Kherson	172,707	12,028	0	0	0	0	0
Ukraine	Kievskoye NPO Masma	L'vov	8,000	0	0	0	0	0	0
Ukraine	Kremenchugnefteorgsintez Joint Stock Co.	Kremenchug	360,000	0	29,600	0	0	6,000	0
Ukraine	Lisichansky NPZ	Lisichansk	481,973	0	30,356	0	0	0	0
Ukraine	Nadvornyansky NPZ	Nadvornaya	74,304	6,954	0	0	0	0	0
Ukraine	Odessky	Odessa	78,321	0	0	0	0	0	0
Uzbekistan	Ferghananefteorgsintez	Ferghana	108,444	17,667	0	0	0	0	0
Uzbekistan	Government	Amtyari	66,271	0	0	0	0	0	0
		Total	**17,494,533**	**397,395**	**1,456,299**	**346,910**	**118,834**	**163,730**	**4,500**

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TABLE 4.8-3
REGIONAL REFINERY CAPACITY, OTHER US- California Affiliates
(Barrels per Stream Day)

Star Enterprise	Delaware City	DE	140,000	41,850	63,000	17,100	8,190	1,260	0
Chevron	Barbers Point	HA	54,000	0	21,000	0	4,000	0	0
Mobil Oil	Joliet	IL	203,700	43,800	93,500	0	26,300	0	0
Shell Wood River Refining Co.	Wood River	IL	271,000	0	85,000	28,500	20,500	3,500	0
Texaco	El Dorado	KS	99,750	15,300	31,320	0	10,800	2,700	0
Exxon	Billings	MT	46,000	7,300	20,000	4,500	3,200	0	0
Chevron	Perth Amboy	NJ	80,000	0	0	0	0	0	0
Mobil Oil	Paulsboro	NJ	149,000	22,600	43,700	0	10,300	0	0
	Total		**1,043,450**	**130,850**	**357,520**	**50,100**	**83,290**	**7,460**	**0**

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TABLE 4.8-4
REGIONAL REFINERY CAPACITY, OTHER- California Affiliates
(Barrels per Stream Day)

Country	Company	Location	Crude	Coking	FCC	Hydro- cracking	Alkylation	Aromatics	Isom
South Africa	Shell and BP South Africa Petroleum Refineries	Durban	156,750	0	31,500	0	2,700	0	0
		Total	**156,750**	**0**	**31,500**	**0**	**2,700**	**0**	**0**

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5. TECHNICAL ASPECTS OF MANUFACTURING REFORMULATED GASOLINE

Technical aspects of manufacturing CARB reformulated gasoline were used to segregate refineries according to their likelihood of being able to meet the CARB specifications. CARB gasoline specifications are the most restrictive automotive gasoline specifications in the world that are widely applied. Meeting the specifications requires refinery equipment not commonly found in all locations.

In this chapter the CARB specifications are reviewed and these specifications are contrasted with typical specifications in other parts of the world. Then the most important features of CARB gasoline blend stocks are identified. Next the key process units that are important to producing CARBOB are discussed. Finally, the problems that refiners in other regions might have in producing CARBOB are reviewed. These discussions set the stage for steps to quantify how much CARBOB refiners in other regions are likely to be able to produce.

5.1 REVIEW OF CARB GASOLINE SPECIFICATIONS

CARB gasoline can be blended using one of three options. First, the refinery may elect to meet "flat limits". Second, the refinery may use averaging. Third, the refinery may use the predictive model.

The system of flat limits establishes a fixed set of gasoline quality criteria, shown in Table 5.1-1. The refiner or importer must ensure that each blend or cargo meets the fixed criteria.

TABLE 5.1-1
CARB REGULATIONS

Quality	Flat Limit
RVP PSIA Max	7
Sulfur PPM Max	40
Benzene Vol % Max	1
Olefin Vol % Max	6
Oxygen	
T50 Deg F Max	210
T90 Deg F Max	300
Aromatics Vol % Max	25

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As opposed to meeting fixed limits, a refiner or importer may satisfy CARB requirements by providing gasoline that meets CARB limits on average, even though any individual batch or cargo may not meet the average limits. In order to use this option, the refiner or importer must meet average limits that are somewhat more stringent than the flat limits.

Also, each cargo is limited in how far out of range it can be and there are "cap limits" that must not be exceeded by any individual batch or cargo. The averaging limits and cap limits are shown in Table 5.1-2.

TABLE 5.1-2
CARB REGULATIONS

Quality	Averaging Limit	Cap Limit
RVP PSIA Max		7
Sulfur PPM Max	30	80
Benzene Vol % Max	0.8	1.2
Olefin Vol % Max	4	10
Oxygen		2.7
T50 Deg F Max	200	220
T90 Deg F Max	290	330
Aromatics Vol % Max	22	30

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The predictive model allows refiners to meet CARB requirements by use of a complicated set of equations. The equations correlate vehicle emissions performance to fuel qualities. Refiners or importers may determine a set of specifications that have satisfactory emissions characteristics according to the predictive model and submit those specifications to CARB. Cap limits still apply and prevent complete freedom on any particular quality characteristic. The predictive model has proven to be very useful to refiners and is widely used to define quality characteristics of California gasoline.

5.1.1 Vapor Pressure

At 7 PSIA or about 48.3 kilopascals, the summertime Reid Vapor Pressure (RVP) specification of CARB gasoline is extremely low by international standards. California manufacturers have responded to these requirements by installing equipment to ensure thorough debutanization of most gasoline components and by depentanizing many streams. Summertime gasoline blending in California uses pentane for vapor pressure control, not the more common butane.

In most other parts of the world, summertime gasoline RVP limits are between 9 and 11.5 psia. These limits have been determined mostly by vehicle performance characteristics including the requirement to avoid gasoline vaporizing in the fuel lines, known as "vapor lock".

5.1.2 Sulfur

CARB gasoline specifications have very low sulfur requirements. Gasoline in much of the world is blended to specifications of 1000 to 1500 ppm while the CARB flat limits call for 40 ppm. Manufacturing gasoline to such low sulfur levels requires desulfurizing most streams including straight run gasolines and FCC feed stocks and/or FCC gasolines.

5.1.3 Benzene

CARB's flat limits call for 1.0% benzene content. In most of the world benzene levels are much higher, up to 5% in some markets. In a few European markets lower benzene levels are being developed but refiners have yet to manufacture such low levels in most locations. Benzene limits are met either by controlling benzene precursor levels in reformer feed stocks or by benzene extraction or saturation. There is very little West Coast market for benzene so benzene extraction is not widely practiced in California. Benzene is a valuable commodity in areas with large petrochemical industries and so there are many benzene extraction plants around the world to satisfy petrochemical demand. Refiners in other parts of the world have not adopted the benzene control strategies based on precursor control or saturation employed by California refiners. Gulf Coast refineries which must produce gasoline with limited benzene content follow benzene control strategies similar to those employed in California.

5.1.4 Olefin

CARB's flat limits call for 6% olefin content. In most parts of the world there are no olefin specifications. Markets that rely on catalytic cracking conversion to manufacture gasoline and use FCC gasoline as a high volume blend stock would be expected to have difficulty meeting stringent olefin specifications. Olefins are produced by such cracking and are concentrated in FCC gasoline. Refiners that rely more heavily on hydrocracking technology would not find high olefin content in their gasoline pools since hydrocrackers do not produce olefins.

5.1.5 Oxygen

CARB specifications do not require any minimum oxygen content. Likewise most countries do not require oxygen in gasoline. A few countries have adopted minimum oxygen requirements, usually using MTBE or other ethers.

5.1.6 Distillation

CARB specifications call for limits on boiling point at the 50% distilled and 90% distilled levels, T50 and T90. These are more stringent than those encountered in most other markets. However, since many other markets maximize kerosene and distillate production rather than gasoline, meeting T90 and T50 limits may not represent a particularly troubling challenge to some refiners.

5.1.7 Aromatics

Aromatics content of CARB gasoline is limited to 25% in flat limits gasoline. Most other parts of the world do not have aromatics limits and gasoline aromatics level can be much higher. Aromatics are high in reformates and FCC gasolines, both mainstays of gasoline volume and production and octane enhancement in most countries.

5.2 ABILITY TO MEET CARB SPECIFICATIONS

Differences between CARB specifications and those found in potential exporting regions limit the ability of other areas to supply CARB gasoline. Potential exporting refiners have, as a group, been obligated to meet only much less stringent specifications. Refiners in locations outside California have not invested as heavily as California refiners have in the kinds of processing important to making CARB gasoline. As a result they cannot produce as much of their gasoline to meet CARB specifications as the California refiners can. From a blend stock point of view, they have fewer blend stocks with suitable qualities and more blend stocks with objectionable qualities.

Alkylate is the ideal CARB gasoline blend stock. Alkylate contains no olefins, no sulfur, no aromatics, no benzene and has low vapor pressure. Alkylate has attractive octane characteristics. There is no property relevant to CARB gasoline in which alkylate has poor characteristics. Alkylate from California refiners and that produced elsewhere is essentially the same in all respects.

There are other blend stocks which, though attractive from some points of view, have shortcomings for manufacturing CARB gasoline. These blend stocks often have different characteristics elsewhere than are found in their California counterparts.

Light hydrocrackate has virtually no sulfur, no benzene, no olefins and low aromatics. However, light hydrocrackate has poor octane characteristics which must be offset by some other component and also has high vapor pressure. California refiners distill their hydrocrackate somewhat differently than most refiners elsewhere but otherwise the materials are quite similar.

Reformates have no sulfur, no olefins, low vapor pressure and high octane, but have appreciable benzene and high aromatics. Reformates in most other regions have much higher concentrations of benzene than California reformates limiting their usefulness for CARBOB.

Desulfurized straight run gasoline has low benzene, no olefins and low sulfur but have relatively high vapor pressure and poor octane. In many areas straight run gasolines are not desulfurized and distillation characteristics may be different. California straight run gasolines tend to be slightly heavier than those elsewhere due to steps taken for benzene control in reformate.

FCC gasoline in California tends to be highly fractionated with some desulfurization available. FCC feed stocks tend to be hydrotreated and have quite low sulfur content limiting the sulfur content of raw FCC gasoline in California. Refiners elsewhere tend not to fractionate their FCC gasoline into as many components and almost never remove sulfur from the FCC gasoline itself.

Many refinery gasoline blend stocks found outside California are not practically usable to manufacture CARB gasoline. Conventional reformate has very high benzene content and high end point which severely limit how much of this material can be used in CARB reformulated gasoline. Many FCC gasolines have very high sulfur content which would prevent them from being more than a few per cent of a CARB gasoline blend regardless of what other components were used. Such blend stocks are useful where they are produced because prevailing gasoline specifications in those areas are much less stringent than CARB specifications. Using such blend stocks for making CARBOB is possible but limited by the refiner's ability to find appropriate combinations of blend stocks such that all requirements are met.

Typical blend stocks available in refineries outside California were evaluated to determine the refiner's ability to produce CARB gasoline with those blend stocks. The blend stocks produced outside California are generally not designed to maximize CARB gasoline volume and are oriented toward other types of specifications. Suitability for producing CARB gasoline is more or less a coincidence for those blend stocks rather than a specific goal.

Some regions have more suitable blend stocks than others. For example, many USGC refiners produce EPA reformulated gasoline and will be complying with the more stringent EPA specifications to be in place after 2000. Hence such refiners already have taken steps to reduce contaminants such as benzene and sulfur. Refiners in other markets such as Latin America have not been called on to produce appreciable quantities of EPA or other reformulated gasoline. In some markets octane-enhancing compounds containing lead (TEL and TML) are still being phased out. In those markets benzene and sulfur limits tend to be much higher. Processing steps used in the U.S. to reduce air toxics have not been universally adopted and blend stocks in other areas can be much higher in objectionable compounds than those found in, for instance, the USGC.

5.3 IMPORTANT FEATURES OF CARB BLEND STOCKS

As described more completely in Section 7.3, possible blends of gasoline using blend stock qualities typical of each region were evaluated. The blends were evaluated using the predictive model to determine how well blend stocks from each region could be used to produce CARBOB. At this point in the analysis, these blend results were used to identify important characteristics of CARBOB that most limit blending opportunities and to identify key blend stocks and process units. Blend stock qualities were used with the assumption that no special control strategies were employed.

The most difficult features of CARBOB to meet will be low sulfur content and low vapor pressure. CARB sulfur limits are so low that many common gasoline streams could be used only in insignificant amounts without exceeding allowable levels. Refiners who are not equipped to thoroughly debutanize gasoline components may find it very difficult to manufacture CARB gasoline.

Sulfur control capability can be estimated by review of publicly available refinery configuration information and knowledge of the typical sulfur contents of various gasoline blend stocks. For each refinery, the capacity for naphtha desulfurization was compared to reformer capacity. Reformer feed stock must always be desulfurized but naphtha desulfurizers also can remove sulfur from light straight run gasoline that can be used for

CARBOB blending. Refineries with a high level of excess naphtha desulfurization are considered likely to have available low sulfur straight run gasoline while those without such capability would have only higher sulfur straight run gasoline. FCC gasoline desulfurization is an unusual process and is not well reported. It was assumed that refineries outside California could not desulfurize FCC gasoline. FCC gasoline sulfur levels were assumed to be related to the type of crude being processed. However, FCC gasoline sulfur levels are typically high enough to severely limit its use in CARBOB blends regardless of crude type.

There is no reliable way to estimate the debutanization capability of refineries from publicly available data sources. As a practical matter, all refineries have some ability to remove butane from gasoline blend stocks. The degree of such capability, that is the minimum vapor pressure to which any particular stream can be produced, cannot be deduced from publicly available statistical data. For purposes of this study it has been assumed that existing debutanization systems can be used to reduce gasoline blend stock vapor pressures to required levels, about 6-7 psia. This assumption is believed not to introduce appreciable overestimation of CARBOB capability.

Other CARBOB specification requirements, T50, T90, olefin, benzene, and aromatics, while difficult to meet if all of a refinery's gasoline is to be produced as CARB, can be readily handled by selected blending for a small part of gasoline production.

5.4 KEY PROCESS UNITS

The key process units contributing to an ability to produce CARB gasoline are considered to be alkylation, naphtha desulfurization, hydrocracking and aromatics extraction. Alkylate is the best blend stock for CARB as it has favorable characteristics on all counts and the alkylation process reduces objectionable olefins in other blend stocks. Naphtha desulfurization, in excess of the desulfurization of reformer feed stocks, is considered an important indicator of ability to control gasoline sulfur content and produces important light gasoline components substantially free of objectionable sulfur or olefins. Hydrocracking products also lack objectionable sulfur and olefins and light hydrocrackate is a suitable substitute for desulfurized light straight run gasoline in manufacturing CARBOB. Aromatics extraction can be used to remove excess aromatics from otherwise acceptable reformate which is low in sulfur and olefins. Aromatics raffinate has poor octane characteristics and relatively unattractive high boiling ranges but may be a useful adjunct to other available blend stocks.

Alkylation, naphtha desulfurization, hydrocracking and aromatics extraction are considered useful indicators of CARB gasoline manufacturing capability. Refiners lacking appreciable amounts of all these types of processing are considered unlikely candidates to be able to manufacture commercially significant quantities of CARB gasoline. Other types of refinery processing such as FCC, reforming and coking, are relevant to a refiner's ability to produce gasoline but are not key to producing CARBOB.

6. SCREENING CRITERIA

Two indexing systems were established to allow the review of capabilities of the world's refineries. The CARB Index is a relative measure of the presence of the types of processing associated with an ability to produce CARB gasoline. The Gasoline Production Index (GPI) is a broader measure of the presence of the types of processing associated with an ability to produce gasoline of any quality.

6.1 CARB INDEX

The CARB Index is a relative measure of the presence of the types of refinery process equipment associated with an ability to produce CARB gasoline. High CARB index does not assure that a refinery will be able to produce CARB gasoline. Some types of equipment needed to produce CARB gasoline such as sufficient storage and segregation capability are not reported and refineries vary in their other burdens and ability to make available for CARB blending high quality materials produced from CARB Index units. Similarly, a low CARB index does not necessarily preclude the facility from producing any CARB gasoline. Some facilities underreport capabilities and sometimes key blend stocks can be acquired from outside the refinery. The CARB Index is used to focus attention on the refineries with the greatest potential to produce CARB gasoline and to help characterize regional refining systems.

6.1.1 Index Components

Most world refineries that lack any alkylation will be unable to produce CARBOB. Alkylate provides a critical high octane component with no objectionable properties which can dilute benzene, aromatics and olefin from other blend stocks to acceptable levels. While it is technically possible to devise a processing scheme to produce CARBOB in refineries with no alkylation, such a scheme would require substantial steps in the direction of benzene control in reformate and other streams. These steps would not be done in the absence of a stringent benzene specification. In light of this situation, for refineries without any alkylation capacity, the CARB Index is defined as zero.

For refineries with at least some alkylation, the CARB Index is calculated by multiplying the reported capacity of each process unit, expressed in barrels per stream day by an index factor which is indicative of the importance or usefulness of that unit to producing CARB gasoline. Most process units have CARB Index factors of zero indicating that their contribution to producing CARB gasoline is not significant. Process units with non-zero CARB Index factors are shown below in Table 6.1.1-1.

TABLE 6.1.1-1
CARB INDEX FACTORS

Alkylation	1.0
Hydrocracking	0.4
Aromatics Extraction	0.3
LSR Naphtha Desulfurization	0.5

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6.1.2 Use of the Index

The CARB Index of every refinery in the world was calculated. Refineries were ranked according to their CARB Indices. Based on discussions with refiners and technical considerations a CARB Index of 10,000 was determined to be the minimum level likely to result in a commercially significant ability to produce CARB gasoline. All refineries outside California known to produce CARB gasoline were found to be above this level and no refinery outside of California with a CARB Index below 10,000 is known to have produced any CARB gasoline. Those refineries with a CARB Index at or above 10,000 were designated as “CARBOB-Capable” and those with a CARB Index below 10,000 were designated as “CARBOB-Incapable”.

6.2 GASOLINE PRODUCTION INDEX

Gasoline Production Index (GPI) is a measure of the presence of the types of process equipment used to produce gasoline. Because some refinery equipment has flexibility to produce various alternative products of which gasoline is only one, GPI is not an absolute measure of a refinery’s ability to produce gasoline. Furthermore, refiners may elect to sell gasoline precursors such as naphtha into alternative markets such as the petrochemicals feed stock market rather than devote them to manufacturing gasoline.

6.2.1 Index Components

A refinery’s GPI score is calculated by multiplying the reported capacity of each process unit expressed in barrels per stream day by its GPI factor, a number indicative of the typical usefulness of that type of processing for producing gasoline blend stocks. Many types of units, such as diesel fuel hydrotreaters, do not contribute meaningfully to the production of gasoline and are assigned GPI factors of zero.

Some process units are typically operated differently in various regions of the world. In the U.S. market, for example, gasoline is typically the key processing objective for refiners and FCC units operate to maximize gasoline production. In other markets, distillates are more important products and FCC units operate with less emphasis on gasoline. To reflect these differences, GPI factors were varied slightly from region to region. Non-zero GPI factors are shown on Table 6.2.1-1 below:

TABLE 6.2.1-1
GPI FACTORS

	Pacific North West	USGC	Carribean	Europe	Latin America	Middle East	Far East
Crude	0.25	0.21	0.10	0.15	0.12	0.12	0.10
Thermal Cracker	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Visbreaker	0.11	0.11	0.11	0.11	0.11	0.11	0.11
FCC	0.55	0.55	0.55	0.45	0.55	0.55	0.40
Hydrocracker	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Alkylation	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Polymerization	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Aromatics	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Reforming	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Desulfurization, LSR	1.00	1.00	1.00	1.00	1.00	1.00	1.00

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6.2.2 Use of the Index

The GPI factors were used with approximate unit utilization factors to estimate the production of gasoline blend stocks of all types from the refineries in each region. The blend stock production figures were used in Section 8 along with an estimate of the fraction of alkylate production that could be devoted to CARBOB, to evaluate blending opportunities in the context of the predictive model.

7. REGIONAL CAPABILITY

In this section, the CARBOB-Capable refineries in each region are identified. Tables in this section include key process unit capacities for each refinery, its CARB Index score and its GPI score. CARB Index score is the determinant of whether a refinery is considered CARBOB-Capable or CARBOB-Incapable.

7.1 PACIFIC NORTH WEST

Table 7.1-1 shows the only five refineries active in the Pacific North West manufacturing gasoline of any type. A review of the configurations of the available refinery capacity suggests that although there is a reasonable potential to supply useful blend stocks, there is only limited potential to supply blended CARBOB.

The bulk of the refinery capacity in the Pacific North West is controlled by refiners with operations in California. These refiners are thought likely to operate their West Coast multi-refinery systems in integrated fashion in the event that supply shortfalls are triggered by any specification change such as an MTBE ban. An exchange of gasoline blend stocks is likely to be as practical in this situation as the provision of CARBOB and would offer more optimization opportunities.

Only one refinery, Shell Anacortes, was identified as CARBOB-Capable. It is believed that a relatively large fraction of the alkylate from that refinery might be released for CARBOB in part because of cross-optimization opportunities with other commonly-owned facilities on the West Coast.

7.2 U.S. GULF COAST

Twenty six coastal refineries were identified as being potentially capable of producing CARB gasoline as shown on Table 7.2-1. Of those twenty six, only one, Valero in Corpus Christi, was identified as clearly having been a supplier of CARB gasoline in the past. Ten of the CARBOB-Capable refineries are affiliated with California gasoline marketers. An additional three refineries were identified as potentially CARBOB-Capable but lack coastal access. These refineries, Phillips in Borger, Texas, and Diamond Shamrock in Sunray/ McKee and Three Rivers, are located in Central or West Texas and were dropped from further consideration.

USGC refineries serve many markets including not only the regional market but also the U.S. East Coast and markets in the Mid-Continent area. In the USGC refineries, gasoline is manufactured to a wide variety of specifications. EPA reformulated gasoline is routinely manufactured at all the sophisticated refineries on the USGC. Many of the refineries are able to produce low benzene reformate which is helpful to manufacturing CARBOB. None of the refineries are believed to possess FCC gasoline desulfurization capability though some sweet crudes are processed and FCC feed stocks may be desulfurized reducing FCC gasoline sulfur from high to moderate levels.

Because of their technical sophistication, petrochemical integration and the needs already to produce some reformulated fuels, the ability of the USGC refineries to produce CARBOB from a given volume of alkylate is equal or superior to all regions of the world other than California.

The volume of alkylate that can be released from USGC refineries is sensitive to whether the MTBE ban is extended nationwide or confined to California. In the event that the MTBE ban is confined to California, then about 20% of USGC alkylate might be released either for CARBOB blending or for direct sales as a blend stock. However, if the MTBE ban is extended nationwide, then burdens on the USGC system will be higher. In that event, we believe that the ability of the USGC refiners to divert alkylate will be cut approximately in half.

7.3 CARIBBEAN

One Caribbean refiner, Hess Oil Virgin Islands, has been identified as an historical supplier of CARB gasoline. One other refiner, Refineria Isla Curazao SA, was identified as a potential CARBOB-Capable refiner as shown in Table 7.3-1. Notwithstanding the substantial size of the Curacao refinery, import records suggest only very limited production of EPA-reformulated gasoline, no more than about 3,000 barrels per day, and few exports to the U.S. market. As a result, Curacao is not considered a likely supplier of CARB fuels.

The Hess Oil Virgin Islands facility is undergoing modifications as a result of a recent transaction between Hess' parent company and PDVSA, the Venezuelan national oil company. The ultimate influence of those modifications on CARBOB capacity cannot be identified at this time. Nevertheless, the reorientation of the refinery more toward heavy, high sulfur Venezuelan crude oils and the addition of more coker processing has the potential to trigger some deterioration in gasoline qualities important to CARBOB manufacturing.

Given the blend stocks that exist today, Hess is thought to possess an ability to transform alkylate into CARBOB similar to that of the Pacific North West region.

7.4 EUROPE

Europe has eighteen refineries which have been identified as potentially CARBOB-capable as shown on Table 7.4-1. One European refiner, Neste Oy in Porvoo, Finland, has actually manufactured CARB gasoline. The European refiners face a variety of different specifications at the moment but are entering a new phase of harmonized regulation.

Currently benzene specifications in Europe are loose by U.S. standards calling for a maximum of five percent in most countries. Some countries have adopted more stringent specifications and Italy, for example, is reducing benzene content by voluntary agreements with the oil companies to 1.4 percent in 1997 and 1 per cent by July 1999.

A program is underway which would harmonize European specifications and reduce emissions in a manner similar to the reformulated fuels programs in the U.S. The final determination has not been made as to what the specifications will be. Proposals call for reductions in sulfur, RVP, aromatics, benzene and olefins as well as an oxygen limit. Sulfur, currently about 300 ppm may fall to the 30-100 ppm range. RVP levels, currently about 68 kPa are proposed to fall to 58 kPa or about 8.4 psia. Proposals for aromatics content range from as low as 23 to as high as 37 per cent compared with an estimated current average value of 40 per cent. Benzene would be reduced from about 2.3 per cent to 0.7 to 2.3 per cent. Olefins would be reduced slightly from current 11 per cent levels to the 8 to 10 per cent range. It is possible that an entirely new proposal will be developed with more stringent requirements. Unlike the U.S. or CARB reformulated fuels programs, there is expected to be no flexibility such as is provided by the complex or predictive models. There may be a phased initiation of the program in various European countries.

Movement toward these reformulated programs in Europe is viewed as helpful to providing CARBOB for California. More European refiners will need to produce low benzene and low sulfur blend stocks for gasoline. The timing of the new programs is expected to be generally consistent with a possible MTBE ban.

7.5 LATIN AMERICA

Latin American refineries do not supply appreciable gasoline to the U.S. Only small amounts of the gasoline that is provided meets EPA reformulated specifications. Four Latin America refiners have been identified as potentially CARBOB-Capable on Table 7.5-1. Three of those refineries are in Venezuela and one is in Brazil.

Venezuela has been a modest supplier of EPA reformulated gasoline to East Coast markets. The Lagoven Judibana Falcon refinery, formerly known as Amuay, is a very large refinery at 571,000 barrels per day and has been the subject of considerable capital investment in recent years. Judibana is a coking refinery with a large alkylation unit. The Maraven Punta Cardon refinery and the Corpoven El Palito refinery are simpler than Judibana but both include appreciable alkylation capacity and score reasonably well on the CARB Index.

Latin American refineries suffer some shortcomings with respect to CARBOB manufacture. These refineries as a group lack sufficient desulfurization to produce appreciable low sulfur materials to combine with alkylate. Most naphtha desulfurization appears to be dedicated to producing reforming feed stocks with very little remaining to desulfurize straight run gasoline. Because of these problems, the ability of the Latin American refineries to transform their available alkylate into CARBOB is unusually poor.

7.6 MIDDLE EAST

The Middle East region includes only two refineries which were considered potentially CARBOB-Capable on Table 7.6-1. Generally, Middle East refineries use simple refining equipment processing sour crude oil to produce mostly distillates and residual fuel oils. As a group the Middle East refiners are unable to produce high quality gasolines and a large volume of leaded fuels still is produced in the area. The two refineries that were identified as CARBOB-Capable were the Saudi Aramco-Mobil Yanbu refinery and the Bahrain Petroleum Company refinery at Awali. Those two refineries were the only two identified in the Middle East as possessing any alkylation capacity.

The two Middle East CARBOB-Capable refineries have some shortcomings with respect to CARBOB manufacture. Because the markets served by the refineries are generally not sensitive to benzene content, benzene levels in blend stocks are expected to be at relatively unconstrained levels. FCC gasoline sulfur content is expected to be relatively high because of the high sulfur content of the crudes found in the region and processed in the Saudi refineries.

The Middle East refineries have some helpful characteristics. Light low sulfur blend stocks available from hydrocrackers assist in meeting specifications and place the Middle East refineries in a superior position to those in Latin America.

7.7 FAR EAST

The Far East region includes sixteen refineries that were identified as potentially CARBOB-Capable. As shown in Table 7.7-1, five of these refineries were in China, five were in Japan, two were in Singapore and one each in Taiwan, South Korea, Australia and Indonesia. Most of the refineries in Asia lack any alkylation capacity, considered key to manufacturing commercial volumes of CARBOB. Furthermore, many refineries lack any sort of conversion equipment and are not effective gasoline producers at all.

Japan’s refineries are poorly equipped to manufacture CARB gasoline for export. Japanese refiners as a group export only small volumes and gasoline is exported very infrequently. Japanese refiners generally lack the ability to segregate special gasoline grades and there is no industry providing third party terminaling services in Japan. Cargo loading equipment is poor and is oriented toward very small coastal carriers used to supply the domestic market.

China has a large refining system though many facilities are plagued by logistical disadvantages. China consumes very large quantities of gasoline and is a net product importer. Nevertheless, there is a reasonable prospect that some of the indicated CARB capability could be translated into actual product shipments.

Singapore is a major source of produce exports to many Asian nations. Product loading facilities are excellent and the refineries as a group are accustomed to manufacturing many different product specifications.

Korea is a reasonable source of product exports. Korean refiners have been exporting appreciable products to regional markets and shipping distances to California are not excessive. The Yukong refinery is extremely large and includes hydrocracking, aromatics and alkylation capacity.

Far East refineries as a group are hampered principally by their poor ability to control benzene. Benzene reduction programs are only beginning in those Asian markets that have them at all.

TABLE 7.1-1
PACIFIC NORTH WEST
(Barrels per Stream Day)

Company	Location	State	Hydro-cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Shell Oil	Anacortes	WA	0	11,500	0	7,500	63,190	15,250	CAPABLE
Subtotal Capable			**0**	**11,500**	**0**	**7,500**	**63,190**	**15,250**	
Texaco	Anacortes	WA	0	8,550	0	450	74,877	8,775	INCAPABLE
Tosco	Ferndale	WA	0	6,000	0	500	41,875	6,250	INCAPABLE
ARCO	Ferndale	WA	50,000	0	0	0	79,680	0	INCAPABLE
U.S. Oil & Refining	Tacoma	WA	0	0	0	1,250	10,200	0	INCAPABLE
Subtotal Incapable			**50,000**	**14,550**	**0**	**2,200**	**206,632**	**15,025**	
TOTAL PACIFIC NORTH WEST			**50,000**	**26,050**	**0**	**9,700**	**269,822**	**30,275**	

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TABLE 7.2-1
U.S. GULF COAST
(Barrels per Stream Day)

Company	Location	State	Hydro-cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Amoco Oil	Texas City	TX	114,000	58,900	42,800	0	309,771	117,340	CAPABLE
Basis Petroleum, Inc.	Houston	TX	0	10,400	5,700	2,100	56,771	13,160	CAPABLE
BP Oil Co.	Belle Chasse	LA	0	34,200	21,150	5,400	140,108	43,245	CAPABLE
Chevron	Pascagoula	MS	58,000	14,800	15,100	0	147,380	42,530	CAPABLE
CITGO	Corpus Christi	TX	0	21,000	0	0	97,130	21,000	CAPABLE
CITGO	Lake Charles	LA	36,000	20,700	4,500	0	178,518	36,450	CAPABLE
Clark	Port Arthur	TX	0	15,500	9,800	0	94,940	18,440	CAPABLE
Coastal Ref. & Mkt.	Corpus Christi	TX	18,500	3,200	17,500	0	47,920	15,850	CAPABLE
Conoco	Lake Charles/Westlake	LA	26,600	10,400	0	1,900	113,220	21,990	CAPABLE
Crown Central	Houston	TX	0	11,700	0	0	62,445	11,700	CAPABLE
Deer Park Refining Limited Partnership	Deer Park	TX	62,600	16,500	17,900	0	141,966	46,910	CAPABLE
Diamond Shamrock	Sunray/McKee	TX	25,000	8,700	0	0	76,400	18,700	CAPABLE
Diamond Shamrock	Three Rivers	TX	25,000	6,000	0	4,000	43,800	18,000	CAPABLE
Exxon	Baton Rouge	LA	22,500	35,000	0	52,400	272,540	70,200	CAPABLE
Exxon	Baytown	TX	24,000	28,000	0	39,200	233,990	57,200	CAPABLE
Fina Oil & Chemical	Port Arthur	TX	0	5,500	13,000	6,500	76,535	12,650	CAPABLE
Koch Refining	Corpus Christi	TX	15,000	20,000	36,000	30,000	142,100	51,800	CAPABLE
Lyondell-CITGO	Houston	TX	0	20,900	13,700	8,000	133,240	29,010	CAPABLE
Marathon Oil	Garyville	LA	0	26,000	0	20,500	122,750	36,250	CAPABLE
Marathon Oil	Texas City	TX	0	10,000	2,500	0	42,300	10,750	CAPABLE
Mobil Oil	Beaumont	TX	50,000	12,200	0	0	162,590	32,200	CAPABLE
Mobil Oil	Chalmette	LA	20,000	12,000	9,600	0	97,138	22,880	CAPABLE
Murphy Oil	Meraux	LA	0	8,000	0	4,000	47,750	10,000	CAPABLE
Phillips 66 Co.	Borger	TX	0	17,500	0	0	74,050	17,500	CAPABLE
Phillips 66 Co.	Sweeny	TX	0	19,000	5,300	16,500	111,380	28,840	CAPABLE
Shell Oil	Norco	LA	35,000	15,000	0	0	138,590	29,000	CAPABLE
Star Enterprise	Convent	LA	45,000	13,050	0	1,800	129,513	31,950	CAPABLE
Star Enterprise	Port Arthur	TX	17,820	18,000	0	0	129,038	25,128	CAPABLE
Valero Refining Co.	Corpus Christi	TX	30,000	10,800	0	9,400	64,279	27,500	CAPABLE
	Subtotal Capable		**625,020**	**502,950**	**214,550**	**201,700**	**3,488,152**	**918,173**	

TABLE 7.2-1 (CONTINUED)
U.S. GULF COAST
(Barrels per Stream Day)

Company	Location	State	Hydro-cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
AGE Refining & Manufacturing	San Antonio	TX	0	0	0	0	1,050	0	INCAPABLE
AIPC	Lake Charles	LA	0	0	0	0	5,796	0	INCAPABLE
Atlas Processing Co. Div of Pennzoil	Shreveport	LA	0	0	0	4,500	9,702	0	INCAPABLE
Basis Petroleum, Inc.	Krotz Springs	LA	0	0	0	3,100	38,376	0	INCAPABLE
Basis Petroleum, Inc.	Texas City	TX	0	5,700	0	2,900	59,490	7,150	INCAPABLE
Calcasieu Refining	Lake Charles	LA	0	0	0	0	2,940	0	INCAPABLE
Calumet	Princeton	LA	0	0	0	0	1,680	0	INCAPABLE
Calumet Lubricants Co.	Cotton Valley	LA	0	0	0	3,600	1,835	0	INCAPABLE
Canal Refining Co.	Church Point	LA	0	0	0	0	1,890	0	INCAPABLE
Chevron	El Paso	TX	0	8,200	0	0	42,932	8,200	INCAPABLE
Coastal Ref. & Mkt.	Mobile Bay	AL	0	0	0	0	3,150	0	INCAPABLE
Ergon Refining	Vicksburg	MS	0	0	0	0	5,250	0	INCAPABLE
Fina Oil & Chemical	Big Spring	TX	0	5,000	1,000	4,500	29,555	7,550	INCAPABLE
Giant Industries	Gallup	NM	0	1,800	0	0	10,843	1,800	INCAPABLE
Giant Refining Co.	Bloomfield	NM	0	0	0	0	8,460	0	INCAPABLE
Howell Hydrocarbons	Channelview	TX	0	0	0	0	504	0	INCAPABLE
Hunt Refining Co.	Tuscaloosa	AL	0	0	0	450	11,021	0	INCAPABLE
LaGloria Oil & Gas	Tyler	TX	0	4,200	0	3,500	25,167	5,950	INCAPABLE
Navajo Refining	Artesia	NM	0	9,400	0	0	32,175	9,400	INCAPABLE
NTPS	Corpus Christi	TX	0	0	0	0	6,300	0	INCAPABLE
Placid Refining	Port Allen	LA	0	3,800	0	0	24,330	3,800	INCAPABLE
Pride Refining	Abilene	TX	0	0	0	0	9,408	0	INCAPABLE
Shell Chemical Co.	St. Rose	LA	0	0	0	0	8,400	0	INCAPABLE
Shell Oil	Odessa	TX	0	3,200	0	3,700	14,423	5,050	INCAPABLE
Shell Oil Products Co.	Saraland	AL	0	0	0	5,000	15,960	0	INCAPABLE
Southland Oil	Lumberton	MS	0	0	0	0	1,218	0	INCAPABLE
Southland Oil	Sandersville	MS	0	0	0	0	2,310	0	INCAPABLE
	Subtotal Incapable		**0**	**41,300**	**1,000**	**31,250**	**374,166**	**48,900**	
	TOTAL USGC		**625,020**	**544,250**	**215,550**	**232,950**	**3,862,317**	**967,073**	

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TABLE 7.3-1
CARIBBEAN
(Barrels per Stream Day)

Country	Company	Location	Hydro-cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Netherlands Antilles	Refineria Isla Curazao SA	Emmastad	0	8,020	0	33,000	76,520	24,520	CAPABLE
Virgin Islands	Hess Oil Virgin Islands Corp.	St. Croix	0	14,000	30,000	0	152,050	23,000	CAPABLE
	Subtotal Capable		**0**	**22,020**	**30,000**	**33,000**	**228,570**	**47,520**	
Aruba	Coastal Aruba Refining Co. N.V.	San Nicolas	38,000	0	0	0	45,402	0	INCAPABLE
Barbados	Mobil Oil Barbados Ltd.	Bridgetown	0	0	0	0	720	0	INCAPABLE
Cuba	Government	Nico Lopez, Havana	0	0	0	250	22,701	0	INCAPABLE
Cuba	Government	Cabaiguan	0	0	0	0	252	0	INCAPABLE
Cuba	Government	Santiago de Cuba	0	0	0	200	12,180	0	INCAPABLE
Cuba	Government	Cienfuegos	0	0	0	200	9,120	0	INCAPABLE
Dominican Republic	Falconbridge Dominicana C por A	La Bonao	0	0	0	6,200	1,920	0	INCAPABLE
Dominican Republic	Refineria Dominicana de Petroleo SA	Haina	0	0	0	0	4,080	0	INCAPABLE
Jamaica	Petrojam Ltd.	Kingston	0	0	0	2,860	3,550	0	INCAPABLE
Martinique	Ste. Anonyme de la Raffinerie des Antilles	Fort-de-France	0	0	0	6,200	1,600	0	INCAPABLE
Puerto Rico	Puerto Rico Sun Oil Co.	Yabucoa	15,600	0	0	0	14,740	0	INCAPABLE
Trinidad	Trinidad and Tobago Oil CL	Pointe-a-Pierre	0	1,200	1,700	0	33,650	1,710	INCAPABLE
	Subtotal Incapable		**53,600**	**1,200**	**1,700**	**15,910**	**149,915**	**1,710**	
	TOTAL CARIBBEAN		**53,600**	**23,220**	**31,700**	**48,910**	**378,485**	**49,230**	

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TABLE 7.4-1
EUROPE
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Belgium	Esso Belgium	Antwerp	0	6,815	0	26,060	58,700	19,845	CAPABLE
Belgium	Fina Raffinaderij Antwerpen-	Antwerp	0	6,700	0	52,600	91,150	33,000	CAPABLE
Finland	Neste Oy	Porvoo	16,000	4,200	0	51,000	57,630	36,100	CAPABLE
France	Elf France	Donges	0	4,300	0	13,580	62,347	11,090	CAPABLE
Germany	Leune-Werke AG	Leuna	40,000	6,000	0	7,000	39,420	25,500	CAPABLE
Germany	Mineraloel Oberrhein	Karlsruhe	0	10,200	0	30,500	110,985	25,450	CAPABLE
Italy	Agip Raffinazione	Sannazzaro, Pavia	30,000	3,200	0	10,300	64,020	20,350	CAPABLE
Italy	Raffineria Mediterranea SrL	Milazzo	50,000	5,000	0	7,500	71,050	28,750	CAPABLE
Italy	Raffineria Siciliana Srl	Gela	0	10,000	6,700	2,650	49,600	13,335	CAPABLE
Italy	Saras SpA	Sarroch	50,000	6,800	0	0	110,500	26,800	CAPABLE
Netherlands	Netherlands Refining Co. NV	Europort & Pernis	0	5,850	0	42,300	96,183	27,000	CAPABLE
Netherlands	Shell Nederland Raffinaderij BV	Pernis	22,000	6,800	0	104,000	115,800	67,600	CAPABLE
United Kingdom	BP Refinery Grangemouth Ltd.	Grangemouth	31,500	4,500	1,000	22,500	54,818	28,650	CAPABLE
United Kingdom	Conoco Ltd.	South Killingholme	0	14,000	4,500	0	91,600	15,350	CAPABLE
United Kingdom	Elf Oil Ltd.	Milford Haven	0	6,400	0	7,500	39,025	10,150	CAPABLE
United Kingdom	Lindsey Oil Refinery Ltd.	Killingholm South Humberside	0	6,300	0	18,200	61,937	15,400	CAPABLE
United Kingdom	Mobil Oil CL	Coryton Essex	0	18,000	0	46,400	68,963	41,200	CAPABLE
United Kingdom	Pembroke Cracking Co.[1]	Milford Haven	0	33,000	0	29,000	73,500	47,500	CAPABLE
United Kingdom	Shell U.K. Ltd.	Stanlow	0	11,000	9,000	14,000	83,150	20,700	CAPABLE
		Subtotal Capable	**239,500**	**169,065**	**21,200**	**485,090**	**1,400,377**	**513,770**	
Austria	OeMV	Schwechat	0	0	0	17,500	45,101	0	INCAPABLE
Belgium	Belgian Refining Corp. NV	Antwerp	0	0	0	9,900	14,122	0	INCAPABLE
Belgium	Nynas Petroleum NV	Antwerp	0	0	0	0	2,250	0	INCAPABLE
Denmark	AS Dansk Shell	Fredericia	0	0	0	9,600	16,815	0	INCAPABLE
Denmark	Dansk Statoil AS	Kalundborg	0	0	0	0	16,280	0	INCAPABLE
Denmark	Kuwait Petroleum Refining (Danmark) A/S	Gulfhavn (Skaelskoer)	0	0	0	12,200	13,741	0	INCAPABLE
Finland	Neste Oy	Naantali	0	0	0	0	13,451	0	INCAPABLE
France	Cie. de Raffinage et de Distribution Total France	La Mede	0	3,000	0	0	37,420	3,000	INCAPABLE
France	Cie. de Raffinage et de Distribution Total France	Gonfreville L'Orcher	0	0	0	26,600	77,190	0	INCAPABLE
France	Cie. de Raffinage et de Distribution Total France	Mardyck	0	0	0	2,000	33,450	0	INCAPABLE
France	Cie. Rhenane de Raffinage	Reichstett-Vendenheim	0	0	0	8,100	21,310	0	INCAPABLE
France	Elf France	Grandpuits	0	3,150	0	13,060	33,309	9,680	INCAPABLE
France	Elf France	Feyzin	0	3,500	2,200	4,990	35,673	6,655	INCAPABLE
France	Esso SAF	Port Jerome	0	5,900	0	700	42,575	6,250	INCAPABLE
France	Esso SAF	Fos sur Mer	0	0	0	71,000	28,800	0	INCAPABLE
France	Mobil Oil Francaise	Notre Dame de Gravenchon	0	0	0	2,700	9,548	0	INCAPABLE
France	Shell Francaise	Berre l'Etang	0	0	0	18,000	34,350	0	INCAPABLE
France	Shell Francaise	Petit Couronne	0	0	0	20,000	31,470	0	INCAPABLE
France	Ste. Francaise des Petroles BP	Lavera	15,300	0	6,600	13,500	50,976	0	INCAPABLE

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TABLE 7.4-1 (CONTINUED)
EUROPE
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Germany	BETA	Wihelmshaven	0	0	0	28,700	27,000	0	INCAPABLE
Germany	BP/AGIP	Vohburg/Ingolstadt	0	0	0	36,900	35,755	0	INCAPABLE
Germany	DEA Mineraloel AG	Wesseling	40,000	0	7,600	6,100	38,860	0	INCAPABLE
Germany	DEA Mineraloel AG	Heide	0	0	5,800	5,000	20,740	0	INCAPABLE
Germany	Deutsche Shell AG	Godorf	36,000	0	17,000	48,000	46,070	0	INCAPABLE
Germany	Deutsche Shell AG	Harburg-Grasbrook	0	0	0	14,000	23,660	0	INCAPABLE
Germany	Erdoel Raffinerie Neustadt GmbH	Neustadt-Donau	0	0	0	6,300	33,560	0	INCAPABLE
Germany	Esso AG	Ingolstadt	0	0	0	13,400	28,125	0	INCAPABLE
Germany	Holburn Europa Raffinerie GmbH	Harburg	0	0	0	20,500	20,138	0	INCAPABLE
Germany	OMV Mineralol Petrochemie	Burghausen	0	0	2,300	0	15,750	0	INCAPABLE
Germany	PCK Schwedt AG	Schwedt	0	6,100	5,000	0	66,498	7,600	INCAPABLE
Germany	Ruhr Oel GmbH	Gelsenkirchen	30,000	0	3,650	4,000	62,300	0	INCAPABLE
Germany	Schmierstoff Raffinerie	Salzbergen	0	0	0	0	465	0	INCAPABLE
Germany	Wintershall AG	Lingen	23,000	0	4,674	0	24,440	0	INCAPABLE
Greece	Hellenic Aspropyrgos Refinery SA	Aspropyrgos	0	0	0	5,200	44,154	0	INCAPABLE
Greece	Motor Oil (Hellas) Corinth Refineries SA	Aghii Theodori	0	2,400	0	6,600	35,142	5,700	INCAPABLE
Greece	Petrola Hellas SA	Elefsis	0	0	0	0	16,200	0	INCAPABLE
Greece	Thessaloniki Refining Co. AE	Thessaloniki	0	0	0	8,400	9,975	0	INCAPABLE
Ireland	Irish Refining Petroleum Corp. Ltd.	Whitegate	0	0	0	1,650	9,750	0	INCAPABLE
Italy	Agip Plus SpA	Livorno	0	0	0	10,000	12,600	0	INCAPABLE
Italy	Agip Raffinazione	Taranto	16,000	0	0	7,000	31,198	0	INCAPABLE
Italy	Agip Raffinazione	Porto Marghera	0	0	0	1,000	19,020	0	INCAPABLE
Italy	Anonima Petroli Italiana	Falconara, Marittima	0	0	0	2,900	19,394	0	INCAPABLE
Italy	Arcola Petrolifera SpA	La Spezia	0	0	0	0	4,950	0	INCAPABLE
Italy	ENI	Priolo	0	4,000	12,000	0	54,150	7,600	INCAPABLE
Italy	Esso Italiana SpA	Augusta, Siracusa	0	7,900	0	500	54,715	8,150	INCAPABLE
Italy	Iplom SpA	Busalla	0	0	0	0	6,975	0	INCAPABLE
Italy	Isab	Priolo Gargallo Melilli	65,000	0	0	26,000	76,100	0	INCAPABLE
Italy	Italiana Energia E Servizi SpA	Frassino, Mantova	0	0	0	7,125	12,306	0	INCAPABLE
Italy	Raffineria di Roma SpA	Rome	0	0	0	6,700	15,701	0	INCAPABLE
Italy	Sarpom	S. Martino Di Trecate	0	0	0	40,500	51,640	0	INCAPABLE
Italy	Tamoil Italia SpA	Cremona	0	0	0	12,800	17,130	0	INCAPABLE
Netherlands	Esso Nederland BV	Rotterdam	33,850	0	12,000	10,660	47,139	0	INCAPABLE
Netherlands	Kuwait Petroleum Europoort BV	Rotterdam	0	0	0	18,600	14,953	0	INCAPABLE
Netherlands	Smid & Hollander Raffinaderij BV	Amsterdam	0	0	0	0	1,500	0	INCAPABLE
Netherlands	Total Raffinaderij Nederland NV	Vlissingen	39,000	0	0	0	37,800	0	INCAPABLE
Norway	Esso Norge AS	Slagen-Valloy	0	0	0	10,500	18,322	0	INCAPABLE
Norway	Norske Shell AS	Sola	0	0	0	6,500	13,350	0	INCAPABLE
Norway	Rafinor AS	Mongstad	0	0	0	400	60,700	0	INCAPABLE

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TABLE 7.4-1 (CONTINUED)
EUROPE
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Portugal	Petrogal	Sines	0	5,400	0	6,300	54,083	8,550	INCAPABLE
Portugal	Petrogal	Leca da Palmeira Porto	0	0	6,282	16,789	13,692	0	INCAPABLE
Spain	Asfaltos Espanoles SA	Tarragona	0	0	0	0	3,150	0	INCAPABLE
Spain	Cia. Espanola de Petroles	San Roque (Cadiz)	0	5,000	13,100	0	57,270	8,930	INCAPABLE
Spain	Cia. Espanola de Petroles	La Rabida Huelva	0	0	2,420	0	24,200	0	INCAPABLE
Spain	Cia. Espanola de Petroles	Tenerife	0	0	0	0	17,200	0	INCAPABLE
Spain	Petroleos del Mediterraneo	Castellon de la Plana	0	0	0	11,700	25,373	0	INCAPABLE
Spain	Petronor SA	Somorrostro Vizcaya	0	4,496	0	10,350	57,824	9,671	INCAPABLE
Spain	Repsol Petroleo SA	Puertollano, Ciudad Real	0	3,300	1,800	0	39,930	3,840	INCAPABLE
Spain	Repsol Petroleo SA	Tarragona	15,000	0	0	0	36,300	0	INCAPABLE
Spain	Repsol Petroleo SA	La Coruna	0	0	0	0	36,820	0	INCAPABLE
Spain	Repsol Petroleo SA	Cartagena Murcia	0	0	0	4,000	18,000	0	INCAPABLE
Sweden	AB Nynas Petroleum	Gothenburg	0	0	0	0	1,875	0	INCAPABLE
Sweden	AB Nynas Petroleum	Nynashamn	0	0	0	0	4,200	0	INCAPABLE
Sweden	OK Petroleum	Gothenburg	0	0	0	0	15,900	0	INCAPABLE
Sweden	Shell Raffinaderi BV	Gothenburg	0	0	0	11,000	19,650	0	INCAPABLE
Sweden	Skandinaviska Raffinaderi AB	Brofjorden-Lysekil	48,600	0	0	62,100	70,383	0	INCAPABLE
Switzerland	Raffinerie de Cressier SA	Cressier	0	0	0	11,000	13,290	0	INCAPABLE
Switzerland	Raffinerie du Sud-Ouest SA	Collombey	0	0	0	6,700	10,800	0	INCAPABLE
Turkey	Anadolu Tasfiyehanesi AS	Mersin	0	0	5,800	7,200	14,250	0	INCAPABLE
Turkey	Turkish Petroleum Refineries Corp.	Izmit	23,000	0	0	13,310	57,130	0	INCAPABLE
Turkey	Turkish Petroleum Refineries Corp.	Aliaga-Izmir	16,500	0	0	12,830	49,517	0	INCAPABLE
Turkey	Turkish Petroleum Refineries Corp.	Kirkkale	14,500	0	0	0	22,783	0	INCAPABLE
Turkey	Turkish Petroleum Refineries Corp.	Batman, Siirt	0	0	0	0	4,718	0	INCAPABLE
United Kingdom	Eastham Refinery Ltd.	Eastham, Cheshire	0	0	0	0	3,300	0	INCAPABLE
United Kingdom	Esso Petroleum CL	Fawley	0	0	0	33,800	95,569	0	INCAPABLE
United Kingdom	Gulf Oil GB	Milford Haven	0	0	0	13,100	16,800	0	INCAPABLE
United Kingdom	Nynas	Dundee	0	0	0	0	1,536	0	INCAPABLE
United Kingdom	Phillips Imperial Petroleum Ltd.	Port Clarence	0	0	0	0	15,000	0	INCAPABLE
United Kingdom	Shell U.K. Ltd.	Shell Haven	24,000	0	0	26,000	23,400	0	INCAPABLE
United Kingdom	Texaco Ltd.	Pembroke, Dyfed	0	0	0	0	29,860	0	INCAPABLE
		Subtotal Incapable	**439,750**	**54,146**	**108,226**	**841,964**	**2,539,857**	**85,626**	
		TOTAL EUROPE	**679,250**	**223,211**	**129,426**	**1,327,054**	**3,940,234**	**599,396**	

Note: 65% Texaco 35% Gulf Oil GB

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TABLE 7.5-1
LATIN AMERICA
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Brazil	President Bernardes (RPBC)	Cubatao, Sao Paulo	0	3,140	7,550	11,320	54,956	11,065	CAPABLE
Mexico	Pemex	Salina Cruz	0	14,100	0	11,000	103,200	19,600	CAPABLE
Venezuela	Corpoven	El Palito Carabobo	0	20,000	3,500	0	62,400	21,050	CAPABLE
Venezuela	Lagoven	Judibana Falcon	0	17,800	0	0	149,158	17,800	CAPABLE
Venezuela	Maraven	Punta Cardon Falcon	0	28,800	0	7,000	127,705	32,300	CAPABLE
		Subtotal Capable	**0**	**83,840**	**11,050**	**29,320**	**497,419**	**101,815**	
Argentina	Destileria Argentina de Petroleo SA	Lomas de Zamora	0	0	0	0	960	0	INCAPABLE
Argentina	Esso SAPA	Campana	0	0	0	5,400	30,087	0	INCAPABLE
Argentina	Esso SAPA	Puerto Galvan	0	0	0	0	4,560	0	INCAPABLE
Argentina	Isaura SA	Bahia Blanca	0	0	0	2,547	7,743	0	INCAPABLE
Argentina	Shell Cia. Argentina de Petroleo SA	Dock Sud	0	1,700	0	300	34,943	1,850	INCAPABLE
Argentina	Sol Petroleo SA	San Francisco Solana, Quillmes	0	0	0	0	720	0	INCAPABLE
Argentina	YPF	Lujan de Cuyo	26,000	0	0	0	55,721	0	INCAPABLE
Argentina	YPF	La Plata	0	0	0	0	68,620	0	INCAPABLE
Argentina	YPF	Plaza Huincul	0	0	0	0	2,832	0	INCAPABLE
Argentina	YPF	Campo Duran	0	0	0	0	3,840	0	INCAPABLE
Argentina	YPF	Dock Sud	0	0	0	0	480	0	INCAPABLE
Argentina	YPF	San Lorenzo	0	0	0	0	6,937	0	INCAPABLE
Bolivia	YPFB	Cochabamba	0	0	0	0	3,107	0	INCAPABLE
Bolivia	YPFB	Santa Cruz	0	0	0	0	2,280	0	INCAPABLE
Bolivia	YPFB	Sucre	0	0	0	0	360	0	INCAPABLE
Brazil	REFAP	Canoas, Rio Grande do Sul	0	0	0	0	15,910	0	INCAPABLE
Brazil	REFCAP	Maua Santo Andre, Sao Paulo	0	0	0	0	10,941	0	INCAPABLE
Brazil	DRGP	Rio Grande do Sul	0	0	0	0	3,150	0	INCAPABLE
Brazil	REDUC	Duque de Caxias, Rio de Janeiro	0	0	0	11,320	52,665	0	INCAPABLE
Brazil	REGAP	Betim, Minas Gerais	0	0	0	11,320	34,570	0	INCAPABLE
Brazil	REVAP	Sao Jose dos Campos, Sao Paulo	0	0	0	17,640	56,409	0	INCAPABLE
Brazil	RLAM	Mataripe, Bahia	0	0	0	0	27,801	0	INCAPABLE
Brazil	REMAN	Manaus, Amazonas	0	0	0	0	2,438	0	INCAPABLE
Brazil	REPLAN	Paulinia, Sao Paulo	0	0	0	0	60,424	0	INCAPABLE
Brazil	REPAR	Araucaria, Parana	0	0	0	0	44,240	0	INCAPABLE
Brazil	RPM	Rio de Janeiro	0	0	0	0	3,131	0	INCAPABLE
Chile	ENAP	Gregorio-Magallanes	0	0	0	0	1,158	0	INCAPABLE
Chile	Petrox SA	Talcahuano	0	0	0	0	24,593	0	INCAPABLE
Chile	Refineria de Concon	Concon	12,580	1,100	0	2,000	30,734	7,132	INCAPABLE

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TABLE 7.5-1 (CONTINUED)
LATIN AMERICA
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Colombia	Empresa Colombiana de Petroleos	Barrancabermeja-Santander	0	2,100	1,600	0	61,690	2,580	INCAPABLE
Colombia	Empresa Colombiana de Petroleos	Cartagena, Bolivar	0	0	0	0	26,890	0	INCAPABLE
Colombia	Empresa Colombiana de Petroleos	Orito, Putumayo	0	0	0	0	216	0	INCAPABLE
Colombia	Empresa Colombiana de Petroleos	Tibu, N. de Santander	0	0	0	0	216	0	INCAPABLE
Colombia	Empresa Colombiana de Petroleos	Apiay	0	0	0	0	270	0	INCAPABLE
Costa Rica	RCP	Limon	0	0	0	0	3,750	0	INCAPABLE
Ecuador	Petroecuador	Esmeraldas	0	0	0	0	13,572	0	INCAPABLE
Ecuador	Petroecuador	Sta. Elena Peninsula	0	0	0	0	5,640	0	INCAPABLE
Ecuador	Petroecuador	Refineria Amazonas	0	0	0	0	2,400	0	INCAPABLE
Ecuador	Petroecuador	Lago-Agrio	0	0	0	0	120	0	INCAPABLE
El Salvador	Refineria Petrolera Acajutla SA	Acajutla	0	0	0	3,700	2,460	0	INCAPABLE
Guatemala	Basic Resources International	Peten	0	0	0	0	480	0	INCAPABLE
Guatemala	Texas Petroleum Co.	Escuintla	0	0	0	0	1,920	0	INCAPABLE
Honduras	Refineria Texas de Honduras SA	Puerto Cortes	0	0	0	1,200	1,680	0	INCAPABLE
Mexico	Pemex	Ciudad Madero	0	3,420	0	0	53,150	3,420	INCAPABLE
Mexico	Pemex	Salamanca	18,500	0	0	13,540	69,640	0	INCAPABLE
Mexico	Pemex	Minatitlan	0	0	17,150	4,000	46,600	0	INCAPABLE
Mexico	Pemex	Cadereyta	0	0	0	16,000	55,700	0	INCAPABLE
Mexico	Pemex	Tula Hidalgo	0	0	0	7,000	86,910	0	INCAPABLE
Nicaragua	Esso Standard Oil SA Ltd.	Managua	0	0	0	1,500	1,980	0	INCAPABLE
Panama	Refineria Panama SA	Las Minas	0	0	0	0	10,170	0	INCAPABLE
Paraguay	Petroleos Paraguayos	Villa Elisa	0	0	0	0	900	0	INCAPABLE
Peru	ANC	Talara	0	0	0	0	16,570	0	INCAPABLE
Peru	Maples Gas	Pucallpa	0	0	0	0	390	0	INCAPABLE
Peru	Petroleos del Peru	La Pampilla Lima	0	0	0	0	15,685	0	INCAPABLE
Peru	Petroleos del Peru	Conchan/Lima	0	0	0	0	780	0	INCAPABLE
Peru	Petroleos del Peru	Iquitos Loreto	0	0	0	0	1,260	0	INCAPABLE
Peru	Petroleos del Peru	Marsella Loreto	0	0	0	0	0	0	INCAPABLE
Uruguay	ANC	La Teja Montevideo	0	0	0	0	10,520	0	INCAPABLE
Venezuela	Corpoven	Puerto La Cruz Anzoategui	0	4,100	0	0	34,650	4,100	INCAPABLE
Venezuela	Corpoven	El Toreno Barinas	0	0	0	0	576	0	INCAPABLE
Venezuela	Corpoven	San Roque, Anzoategui	0	0	0	0	624	0	INCAPABLE
		Subtotal Incapable	**57,080**	**12,420**	**18,750**	**97,467**	**1,118,763**	**19,082**	
		TOTAL LATIN AMERICA	**57,080**	**96,260**	**29,800**	**126,787**	**1,616,182**	**120,897**	

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TABLE 7.6-1
MIDDLE EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Bahrain	Bahrain Petroleum Co.	Awali	48,600	3,060	0	900	78,517	22,950	CAPABLE
Saudi Arabia	Saudi Aramco-Mobil	Yanbu	40,000	23,500	0	26,800	134,205	52,900	CAPABLE
		Subtotal Capable	**88,600**	**26,560**	**0**	**27,700**	**212,722**	**75,850**	
Abu Dhabi	Abu Dhabi National Oil Co.	Ruwais	26,730	0	0	3,240	26,538	0	INCAPABLE
Abu Dhabi	Abu Dhabi National Oil Co.	Umm Al-Nar	0	0	0	23,310	9,690	0	INCAPABLE
Cyprus	Cyprus Petroleum Refinery Ltd.	Larnaca	0	0	0	0	3,120	0	INCAPABLE
Fujairah	Metro Oil Corporation	Fujairah	0	0	0	0	4,200	0	INCAPABLE
Iran	National Iranian Oil Co.	Tehran	57,200	0	0	0	53,730	0	INCAPABLE
Iran	National Iranian Oil Co.	Isfahan	30,000	0	0	0	47,980	0	INCAPABLE
Iran	National Iranian Oil Co.	Arak	24,500	0	0	0	30,803	0	INCAPABLE
Iran	National Iranian Oil Co.	Tabriz	18,000	0	0	0	22,455	0	INCAPABLE
Iran	National Iranian Oil Co.	Shiraz	9,280	0	0	0	9,502	0	INCAPABLE
Iran	National Iranian Oil Co.	Abadan	0	0	0	0	64,500	0	INCAPABLE
Iran	National Iranian Oil Co.	Lavan	0	0	0	0	2,400	0	INCAPABLE
Iran	National Iranian Oil Co.	Kermanshah (Bakhtaran)	0	0	0	0	3,600	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Baiji, North	38,000	0	4,000	0	33,200	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Dorah	0	0	0	0	11,040	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Basrah	0	0	0	0	15,120	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Haditha	0	0	0	0	840	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Khanaqin	0	0	0	0	1,440	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Nassiriyah	0	0	0	0	3,240	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Qayyarah	0	0	0	0	1,500	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Kirkuk	0	0	0	0	3,240	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Baiji, Sulahuddin	0	0	0	0	16,800	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Al Jezira	0	0	0	0	2,400	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Al Syniya	0	0	0	0	2,400	0	INCAPABLE
Iraq	Ministry of Oil, Refinery Admin.	Kasek	0	0	0	0	2,400	0	INCAPABLE
Israel	Oil Refineries Ltd.	Haifa	0	0	5,000	1,000	34,410	0	INCAPABLE
Israel	Oil Refineries Ltd.	Ashdod	0	0	0	8,500	28,675	0	INCAPABLE
Jordan	Jordan Petroleum Refinery	Zarqa	4,230	0	0	5,760	16,085	0	INCAPABLE

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TABLE 7.6-1 (CONTINUED)
MIDDLE EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Kuwait	Kuwait National Petroleum Co.	Shuaiba	82,000	0	0	11,000	51,280	0	INCAPABLE
Kuwait	Kuwait National Petroleum Co.	Mina Abdulla	38,000	0	0	7,200	56,600	0	INCAPABLE
Kuwait	Kuwait National Petroleum Co.	Mina Al-Ahmadi	36,000	0	0	2,000	79,600	0	INCAPABLE
Neutral Zone	Arabian Oil CL	Al Khafji	0	0	0	0	3,600	0	INCAPABLE
Oman	Oman Refinery Co.	Mina Al Fahal	0	0	0	4,000	10,200	0	INCAPABLE
Qatar	QGPC	Umm Saeed	0	0	0	8,000	6,900	0	INCAPABLE
Saudi Arabia	Arabian Oil Co. Ltd.	Ras Al Khafji	0	0	0	0	3,600	0	INCAPABLE
Saudi Arabia	Jeddah Refining Company	Jeddah	10,000	0	0	0	20,990	0	INCAPABLE
Saudi Arabia	Saudi Aramco	Riyadh	33,820	0	0	0	30,328	0	INCAPABLE
Saudi Arabia	Saudi Aramco	Ras Tanura	0	0	0	0	36,000	0	INCAPABLE
Saudi Arabia	Saudi Aramco	Yanbu	0	0	0	0	22,800	0	INCAPABLE
Saudi Arabia	Saudi Aramco	Rabigh	0	0	0	0	34,800	0	INCAPABLE
Saudi Arabia	Saudi Aramco-Shell	Jubail	44,000	0	5,800	61,000	56,160	0	INCAPABLE
Syria	Banias Refining Co.	Banias	25,000	0	0	0	28,950	0	INCAPABLE
Syria	Homs Refinery Co.	Homs	0	0	0	9,611	16,934	0	INCAPABLE
Yemen	Aden Refinery Co.	Aden	0	0	0	0	13,200	0	INCAPABLE
Yemen	Ministry of Oil and Mineral Resources	Marib	0	0	0	0	1,200	0	INCAPABLE
		Subtotal Incapable	**476,760**	**0**	**14,800**	**144,621**	**924,449**	**0**	
		TOTAL MIDDLE EAST	**565,360**	**26,560**	**14,800**	**172,321**	**1,137,171**	**75,850**	

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TABLE 7.7-1
FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Australia	Ampol Refineries (NSW) Pty. Ltd.	Kurnell	0	7,800	0	17,500	43,625	16,550	CAPABLE
China	Baling Petrochemical	Baling	9,000	2,000	0	22,000	37,801	16,600	CAPABLE
China	Dalian Petrochemical	Dalian	20,000	2,000	0	3,000	52,258	11,500	CAPABLE
China	Maoming Petrochemical	Maoming	16,000	1,000	1,000	13,000	43,030	14,200	CAPABLE
China	Qilu Petrochemical	Qilu	42,000	3,000	0	19,000	57,146	29,300	CAPABLE
China	Shanghai Petrochemical	Jinshan	18,000	2,400	4,400	0	20,244	10,920	CAPABLE
Indonesia	Pertamina	Musi	0	16,200	0	0	39,586	16,200	CAPABLE
Japan	Idemitsu Kosan CL	Chita, Aichi	0	9,000	0	7,200	46,600	12,600	CAPABLE
Japan	Japan Energy	Mizushima	0	7,200	0	18,100	41,804	16,250	CAPABLE
Japan	Mitsubishi Oil CL	Mizushima	11,000	7,600	12,800	8,000	61,000	19,840	CAPABLE
Japan	Nippon Petroleum Refining CL	Negishi	0	3,960	0	17,550	68,075	12,735	CAPABLE
Japan	Tonen	Kawasaki	0	6,615	0	13,090	60,102	13,160	CAPABLE
Korea S.	Yukong Ltd.	Ulsan	27,000	5,400	27,900	6,210	111,150	27,675	CAPABLE
Singapore	Shell Eastern Petroleum Ltd.	Pulau Bukom	28,600	3,000	0	0	78,680	14,440	CAPABLE
Singapore	Singapore Refining Co. Pte. Ltd.	Pulau Merlimau	30,300	4,200	0	200	59,064	16,420	CAPABLE
Taiwan	Chinese Petroleum Corp.	Kaohsiung	18,080	3,200	60,000	2,500	91,728	29,682	CAPABLE
		Subtotal Capable	**219,980**	**84,575**	**106,100**	**147,350**	**911,893**	**278,072**	
Australia	Ampol Refineries Ltd.	Lytton	0	3,300	0	0	27,200	3,300	INCAPABLE
Australia	Australian Lubricating Oil Refinery Ltd.	Kurnell	0	0	0	0	0	0	INCAPABLE
Australia	BP Australia	Kwinana	0	2,430	0	11,700	28,548	8,280	INCAPABLE
Australia	BP Australia	Bulwer Island	0	1,890	0	10,800	16,025	7,290	INCAPABLE
Australia	Inland Oil Refiners	Eromanga	0	0	0	0	150	0	INCAPABLE
Australia	Mobil Oil Australia Ltd.	Altona	0	2,500	0	12,500	21,960	8,750	INCAPABLE
Australia	Mobil Oil Australia Ltd.	Adelaide (Port Stanvac)	0	0	0	0	6,840	0	INCAPABLE
Australia	Shell Refining (Australia) PL	Geelong	0	4,500	0	0	32,850	4,500	INCAPABLE
Australia	Shell Refining (Australia) PL	Clyde	0	3,000	0	0	27,270	3,000	INCAPABLE
Bangladesh	Eastern Refinery Ltd.	Chittagong	1,180	0	0	290	4,736	0	INCAPABLE
Brunei	Brunei Shell Petroleum CL	Seria	0	0	0	0	860	0	INCAPABLE
Burma	Myanmar Petrochemical Enterprise	Chauk	0	0	0	0	600	0	INCAPABLE
Burma	Myanmar Petrochemical Enterprise	Thanlyin (Mann)	0	0	0	0	3,536	0	INCAPABLE

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TABLE 7.7-1 (CONTINUED)
FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
China	Anqing Petrochemical	Anqing	0	1,000	0	4,000	19,825	3,000	INCAPABLE
China	Anshan Petrochemical	Anshan	0	0	0	0	15,501	0	INCAPABLE
China	Asphalt Plant of Liaohe Oil Field	Panjin	0	0	0	0	3,012	0	INCAPABLE
China	Baoding Petrochemical	Boading	0	0	0	0	803	0	INCAPABLE
China	Cangzhou Oil Refining	Cangzhou	0	0	0	0	6,010	0	INCAPABLE
China	Dagang Refinery	Dagang	0	0	0	0	2,008	0	INCAPABLE
China	Daqing Chemical Plant	Daqing	0	0	0	0	602	0	INCAPABLE
China	Daqing Petrochemical	Daqing	8,000	1,000	1,500	8,000	23,185	8,650	INCAPABLE
China	Duzishan Refining	Duzishan	8,000	0	0	2,000	16,040	0	INCAPABLE
China	Fujian Oil Refining	Fujian	0	0	0	0	13,221	0	INCAPABLE
China	Fushun Petrochemical	Fushun	8,000	3,000	0	0	66,872	6,200	INCAPABLE
China	Golmud Refinery	Qinhau	0	0	0	0	2,008	0	INCAPABLE
China	Guangzhou Petrochemical	Guangzhou	0	1,000	0	12,000	34,200	7,000	INCAPABLE
China	Hangzhou Refinery	Hangzhou	0	0	0	0	321	0	INCAPABLE
China	Harbin Refinery	Harbin	0	0	0	0	5,412	0	INCAPABLE
China	Huabei Chemical Pharmaceutical Plant	Shijiazhuang	0	0	0	0	402	0	INCAPABLE
China	Jianghan Petrochemical Plant	Qianjiang	0	0	0	0	241	0	INCAPABLE
China	Jiangnan Refinery	Jilin	0	0	0	0	602	0	INCAPABLE
China	Jilin Refinery	Qiangou	0	0	0	0	301	0	INCAPABLE
China	Jinan Oil Refining	Jinan	0	0	0	4,000	14,825	0	INCAPABLE
China	Jingmen Oil Refining	Jingmen	8,000	0	0	11,000	22,681	0	INCAPABLE
China	Jinling Petrochemical	Jinling	16,600	1,000	0	0	40,800	7,640	INCAPABLE
China	Jinxi Chemical	Jinxi	0	1,200	0	2,000	21,941	2,200	INCAPABLE
China	Jinzhou Petrochemical	Jinzhou	0	0	0	2,000	21,045	0	INCAPABLE
China	Jiujiang Oil Refining	Jiujiang	8,000	0	0	5,000	17,821	0	INCAPABLE
China	Karamay Refinery	Karamay	0	0	0	0	3,314	0	INCAPABLE
China	Lanzhou Chemical Industry Corp.	Lanzhou	0	0	0	0	1,700	0	INCAPABLE
China	Lanzhou Refining	Lanzhou	0	1,000	0	1,000	20,641	1,500	INCAPABLE
China	Liaoyang Chemical Fiber Corp.	Liaoyang	0	0	1,400	0	18,230	0	INCAPABLE
China	Linyuan Refinery	Linyuan	0	0	0	0	9,812	0	INCAPABLE
China	Luoyang Oil Refining	Luoyang	0	2,000	0	2,000	28,443	3,000	INCAPABLE
China	Majiatan Refinery	Lingwu	0	0	0	0	201	0	INCAPABLE
China	Maling Refinery	Qingyang	0	0	0	0	602	0	INCAPABLE
China	Mudanjiang Dongfanghong Refinery	Mudanjiang	0	0	0	0	402	0	INCAPABLE
China	Nanchong Refinery	Nanchong	0	0	0	0	301	0	INCAPABLE
China	Qianguo Oil Refining	Qianguo	0	0	0	0	12,612	0	INCAPABLE
China	Qingdao Petrochemical Plant	Qingdao	0	0	0	0	1,305	0	INCAPABLE
China	Refinery of Henan Oil Administration	Nanyang	0	0	0	0	241	0	INCAPABLE
China	Refinery of Jilin Petrochemical Co.	Jilin	0	0	0	0	8,635	0	INCAPABLE
China	Shanghai Gaoqiao Petrochemical	Shanghai Gaoqiao	0	1,000	0	0	32,600	1,000	INCAPABLE

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TABLE 7.7-1 (CONTINUED)
FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
China	Shengli Heavy Oil Plant	Dongying	0	0	0	0	2,008	0	INCAPABLE
China	Shengli Refinery	Dongying	0	0	0	0	301	0	INCAPABLE
China	Shijia Oil Refining	Shijiazhuang	0	1,000	0	0	19,400	1,000	INCAPABLE
China	Shongyuan Multi-Processing Plant	Puyang	0	0	0	0	301	0	INCAPABLE
China	Tianjin Petrochemical	Tianjin	0	1,000	2,000	0	27,050	1,600	INCAPABLE
China	Tianyang Refinery	Tianyang	0	0	0	0	100	0	INCAPABLE
China	Urumqi General Petrochemical	Wulumuqi	0	0	0	0	12,861	0	INCAPABLE
China	West Pacific Petrochemical	Dalian	0	2,250	0	0	26,870	2,250	INCAPABLE
China	Wuhan Oil Refining	Wuhan	0	1,000	0	0	14,021	1,000	INCAPABLE
China	Yanchang Oil & Mineral Administration	Yanchang	0	0	0	0	1,406	0	INCAPABLE
China	Yangzi Petrochemical	Yangzi	24,000	0	0	0	30,025	0	INCAPABLE
China	Yanshan Petrochemical	Yanshan	0	1,000	0	0	34,258	1,000	INCAPABLE
China	Yumen Refinery	Yumen	0	0	0	0	3,012	0	INCAPABLE
China	Zepu Petrochemical Plant	Zepu	0	0	0	0	301	0	INCAPABLE
China	Zhenhai Petrochemical	Zhenhai	0	1,000	0	0	27,778	1,000	INCAPABLE
India	Bharat Petroleum CL	Mahul Bombay	0	0	13,000	0	24,988	0	INCAPABLE
India	Bongaigaon Refinery & Petrochemicals Ltd.	Bongaigaon Assam	0	0	694	0	4,453	0	INCAPABLE
India	Cochin Refineries Ltd.	Cochin	0	0	12,000	0	27,902	0	INCAPABLE
India	Hindustan Petroleum CL	Mahul Bombay	0	0	0	0	15,845	0	INCAPABLE
India	Hindustan Petroleum CL	Mangalore	18,900	0	0	0	14,966	0	INCAPABLE
India	Hindustan Petroleum CL	Visakhapatnam	0	0	0	0	16,717	0	INCAPABLE
India	IBP CL	Numaligarh	0	0	0	0	12,350	0	INCAPABLE
India	Indian Oil CL	Barauni	0	0	0	0	10,180	0	INCAPABLE
India	Indian Oil CL	Digboi	0	0	0	0	1,323	0	INCAPABLE
India	Indian Oil CL	Gawahati	0	0	0	0	3,072	0	INCAPABLE
India	Indian Oil CL	Haldia	0	0	0	0	7,156	0	INCAPABLE
India	Indian Oil CL	Koyali	25,000	0	6,000	0	38,655	0	INCAPABLE
India	Indian Oil CL	Mathura	0	0	0	0	25,580	0	INCAPABLE
India	Madras Refineries Ltd.	Madras	0	0	0	0	17,566	0	INCAPABLE
Indonesia	Pertamina	Balikpapan	49,500	0	0	0	43,892	0	INCAPABLE
Indonesia	Pertamina	Balongan (EXOR-I)	0	0	0	0	58,700	0	INCAPABLE
Indonesia	Pertamina	Cepu	0	0	0	0	342	0	INCAPABLE
Indonesia	Pertamina	Cilacap	0	0	0	0	34,004	0	INCAPABLE
Indonesia	Pertamina	Dumai	50,220	0	0	0	37,352	0	INCAPABLE
Indonesia	Pertamina	Pangakalan Brandan	0	0	0	0	475	0	INCAPABLE
Indonesia	Pertamina	Sungaipakning	0	0	0	0	4,750	0	INCAPABLE
Indonesia	Pertamina	Wonokomo	0	0	0	0	300	0	INCAPABLE

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TABLE 7.7-1 (CONTINUED)
FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro-Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Japan	Cosmo Oil CL	Sakai	0	7,200	0	2,700	25,570	8,550	INCAPABLE
Japan	Cosmo Oil CL	Chiba	0	0	0	8,550	35,400	0	INCAPABLE
Japan	Cosmo Oil CL	Yokkaichi City	0	0	0	0	23,725	0	INCAPABLE
Japan	Cosmo Oil CL (Asia Oil Co.)	Sakaide	0	0	0	0	20,140	0	INCAPABLE
Japan	Fuji Oil CL	Sodegaura	21,600	0	7,402	11,700	29,610	0	INCAPABLE
Japan	General Sekiyu Seisei KK	Sakai	0	0	19,800	5,400	28,440	0	INCAPABLE
Japan	Idemitsu Kosan CL	Himeji	0	0	0	9,900	13,300	0	INCAPABLE
Japan	Idemitsu Kosan CL	Ichihara, Chiba	10,440	0	12,060	7,200	43,046	0	INCAPABLE
Japan	Idemitsu Kosan CL	Tokuyama	0	0	0	0	20,400	0	INCAPABLE
Japan	Idemitsu Kosan CL	Tomakomai	13,500	0	0	8,100	27,110	0	INCAPABLE
Japan	Japan Energy	Chita	0	0	15,300	5,800	14,720	0	INCAPABLE
Japan	Japan Energy	Funakawa	0	0	0	0	600	0	INCAPABLE
Japan	Kainan Petroleum Refining CL	Kaiwan City	0	0	0	0	5,000	0	INCAPABLE
Japan	Kashima Oil CL	Kashima	0	0	2,900	900	26,820	0	INCAPABLE
Japan	Koa Oil CL	Osaka	0	4,000	2,100	1,000	24,400	5,130	INCAPABLE
Japan	Koa Oil CL	Marifu	0	0	7,500	8,000	24,920	0	INCAPABLE
Japan	Kyenus Sekiyu Seisei KK	Kawasaki	0	0	0	0	6,650	0	INCAPABLE
Japan	Kyokuto Petroleum Ltd.	Chiba	35,000	0	0	2,500	39,500	0	INCAPABLE
Japan	Kyushu Oil CL	Oita	11,000	0	0	1,000	24,000	0	INCAPABLE
Japan	Mitsubishi Oil CL	Kawasaki	0	0	0	0	7,500	0	INCAPABLE
Japan	Nansei Sekiyu KK	Nishihara	0	0	0	10,400	10,000	0	INCAPABLE
Japan	Nihonkai Oil CL	Toyama	0	0	0	4,000	6,000	0	INCAPABLE
Japan	Nippon Oil CL	Niigata	0	0	0	0	4,270	0	INCAPABLE
Japan	Nippon Petroleum Refining CL	Muroran	36,000	0	0	14,400	38,830	0	INCAPABLE
Japan	Nippon Petroleum Refining CL	Nakagusuku	0	0	0	0	0	0	INCAPABLE
Japan	Nippon Petroleum Refining CL	Yokohama (Dismantled)	0	0	0	180	0	0	INCAPABLE
Japan	Nippon Refining	Kudamatsu	0	0	0	0	0	0	INCAPABLE
Japan	Okinawa Sekiyu Seisei	Yonashiro	0	0	0	5,000	11,000	0	INCAPABLE
Japan	Seibu Oil CL	Yamaguchi	0	0	0	8,100	22,020	0	INCAPABLE
Japan	Showa Shell Sekiyu KK	Kawasaki	0	0	3,300	5,800	11,010	0	INCAPABLE
Japan	Showa Shell Sekiyu KK	Niigata	0	0	0	0	3,670	0	INCAPABLE
Japan	Showa Yokkaichi Sekiyu CL	Yokkaichi	0	0	5,500	20,900	31,070	0	INCAPABLE
Japan	Taiyo Oil CL	Ehime	16,200	0	11,800	6,300	14,935	0	INCAPABLE
Japan	Teiseki Topping Plant	Kubiki	0	0	0	0	419	0	INCAPABLE
Japan	Toa Oil CL	Kawasaki	0	0	0	11,340	25,363	0	INCAPABLE
Japan	Toho Oil CL	Owase	0	0	0	0	3,500	0	INCAPABLE
Japan	Tohoku Oil CL	Sendai	0	0	0	0	18,390	0	INCAPABLE
Japan	Tonen	Wakayama	0	2,079	0	0	31,374	2,079	INCAPABLE
Korea N.	Government	Paengma-ri	0	0	0	0	2,900	0	INCAPABLE
Korea N.	Government	Sonbong	0	0	1,000	100	4,200	0	INCAPABLE

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TABLE 7.7-1 (CONTINUED)
FAR EAST
(Barrels per Stream Day)

Country	Company	Location	Hydro- Cracking	Alkylation	Aromatics	Excess Naphtha HDS	GPI Factors	CARB SCORE	CARB CAPABILITY
Korea S.	Hanhwa	Inchon	0	0	18,000	0	26,125	0	INCAPABLE
Korea S.	Hundai	Busan	0	0	0	1,800	0	0	INCAPABLE
Korea S.	Hyundai Oil Ref Co.	Daesan	22,000	0	0	7,000	41,670	0	INCAPABLE
Korea S.	LG-Caltex	Yosu	0	0	20,700	7,200	82,200	0	INCAPABLE
Korea S.	Ssangyong Oil Refining CL	Onsan	27,000	0	9,600	0	52,695	0	INCAPABLE
Malaysia	Esso Malaysia Berhad	Port Dickson	0	0	0	9,700	8,000	0	INCAPABLE
Malaysia	Petronas	Melaka	0	0	0	0	10,000	0	INCAPABLE
Malaysia	Petronas Penapisan Sdn. Berhad	Kerteh	0	0	0	0	7,500	0	INCAPABLE
Malaysia	Sarawak Shell Berhad	Luton	0	0	0	0	4,500	0	INCAPABLE
Malaysia	Shell Refining Co. Berhad	Port Dickson	0	0	0	15,000	10,500	0	INCAPABLE
New Zealand	New Zealand Refining	Whangarei	24,300	0	0	9,900	18,840	0	INCAPABLE
Pakistan	Attock Refinery Ltd.	Rawalpindi	0	0	0	0	2,898	0	INCAPABLE
Pakistan	National Refinery Ltd.	Karachi	0	0	0	0	6,205	0	INCAPABLE
Pakistan	Pakistan Refinery Ltd.	Karachi	0	0	0	0	4,630	0	INCAPABLE
Philippines	Caltex (Philippines) Inc.	Batangas	0	0	0	0	12,200	0	INCAPABLE
Philippines	Petron Corp.	Limay	0	0	0	17,100	20,125	0	INCAPABLE
Philippines	Philippine Petroleum Corp.	Pililla	0	0	0	0	0	0	INCAPABLE
Philippines	Pilipinas Shell Petroleum	Tabangao	0	0	0	12,200	21,490	0	INCAPABLE
Singapore	BP Refinery Singapore PL	Pasir Panjang	0	0	0	0	0	0	INCAPABLE
Singapore	Esso Singapore PL	Pulau Ayer Chawan	4,400	0	0	11,400	29,410	0	INCAPABLE
Singapore	Mobil Oil Singapore PL	Jurong	26,000	0	15,000	24,000	42,060	0	INCAPABLE
Sri Lanka	Ceylon Petroleum Corp.	Sapugaskanda	0	0	0	0	5,988	0	INCAPABLE
Taiwan	Chinese Petroleum Corp.	Taoyuan	0	0	0	6,200	20,000	0	INCAPABLE
Thailand	Bangchak Petroleum	Bangkok	0	0	0	1,350	12,000	0	INCAPABLE
Thailand	Esso Standard Thailand Ltd.	Sriracha	0	0	0	11,500	27,400	0	INCAPABLE
Thailand	Fang Refining	Fang	0	0	0	0	170	0	INCAPABLE
Thailand	Rayong Refining	Rayong	40,000	0	0	0	32,700	0	INCAPABLE
Thailand	Star Petroleum	Map Ta Phut	0	0	0	0	25,670	0	INCAPABLE
Thailand	Thai Oil CL	Sriracha	19,900	0	0	0	35,054	0	INCAPABLE
Thailand	Thai Petrochemical Co.	Rayong	0	0	0	0	6,500	0	INCAPABLE
		Subtotal Capable	**532,740**	**50,349**	**188,556**	**381,910**	**2,505,884**	**98,919**	
		TOTAL	**752,720**	**134,924**	**294,656**	**529,260**	**3,417,777**	**376,991**	

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8. KEY COMPONENT AVAILABILITY

The volume of CARBOB that can be produced from a region will be assessed in two steps. First, an estimate will be made of the volume of alkylate that can be made available. This volume will depend on total alkylate production capability and an estimate of the fraction of total alkylate that might be released for CARBOB production. Alkylate from CARBOB-Incapable refineries is assumed not to be available and only a fraction of alkylate from CARBOB-Capable refineries might be released. The second step involves an estimate of the volume of CARBOB that can be produced from each volume of alkylate. The principal factors influencing this ratio are the volumes and qualities of other blend stocks that can be combined with the alkylate.

8.1 ALKYLATE

Table 8.1-1 shows the alkylate capacity of CARBOB-Capable refineries in each region. In addition this table shows our estimate of the total production of alkylate from CARBOB-Capable refineries in each region. Like any refinery process unit, alkylation units do not regularly produce at 100% of capacity. A lower utilization is common resulting from unit maintenance downtime as well as feed availability and economic issues. Alkylation units normally are constructed as adjuncts to FCC units which are economically important to refinery operations. Often FCC units operate at higher utilization rates than refineries as a whole. Consistent with information from diverse data sources and based on other work prepared by Purvin & Gertz, utilization rates have been assigned for alkylation units in each region ranging from 75% to 85%.

TABLE 8.1-1
ALKYLATE AVAILABILITY
(Barrels per Day)

	Alkylate Capacity	Estimated Production	Alkylate Availability
Pacific North West	12,000	10,000	4,000
U.S. Gulf Coast	503,000	428,000	86,000
Caribbean	22,000	18,000	11,000
Europe	158,000	134,000	27,000
Latin America	84,000	63,000	25,000
Middle East	27,000	21,000	8,000
Far East	85,000	68,000	14,000
TOTAL	**891,000**	**742,000**	**175,000**

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Furthermore, alkylate availability for CARBOB was estimated. These estimates were prepared based on discussions with refiners and in light of our own views of technical factors limiting alkylate availability in the USGC region which is responsible for over half of all alkylate production in the world. Alkylate availability for CARBOB doesn't necessarily translate into alkylate availability for sale as a gasoline blend stock.

8.2 OTHER COMPONENTS

Table 8.2-1 shows the estimated availabilities of other gasoline blend stocks. These volumes were determined based on the production capacity of each type of process unit from CARBOB-Capable refineries. Those capacities were multiplied by the GPI factors for each process unit, a typical yield of gasoline-range material from the units, and a standard 85% utilization factor.

TABLE 8.2-1
MAJOR BLEND STOCK PRODUCTION
CARBOB CAPABLE REFINERIES
(Barrels per Day)

	Hydrocrackate	Desulfurized, LSR	Aromatics Raffinate	FCC Gasoline	Reformate	Total
Pacific North West	0	6,000	0	21,000	18,000	45,000
U.S. Gulf Coast	213,000	171,000	55,000	1,105,000	1,112,000	2,656,000
Caribbean	0	28,000	8,000	81,000	105,000	222,000
Europe	81,000	400,000	3,000	344,000	397,000	1,225,000
Latin America	0	25,000	3,000	193,000	70,000	291,000
Middle East	30,000	24,000	0	62,000	45,000	161,000
Far East	75,000	125,000	27,000	242,000	335,000	804,000
TOTAL	**399,000**	**779,000**	**96,000**	**2,048,000**	**2,082,000**	**5,404,000**

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No estimate was made of the fraction of each of the other blend stocks that could be made available for CARBOB blending. First, the total volumes of other blend stocks tend to be much greater than alkylate. Hence alkylate is the blend stock typically in shortest supply. Second, while alkylate is a key ingredient in a few high value products such as premium gasoline, reformulated gasoline or aviation gasoline, none of the other components is particularly important to any end product other than conventional regular grade motor gasoline. The opportunity cost of conventional regular grade motor gasoline will be the starting point for calculating the cost of producing CARBOB. While diverting too much alkylate toward CARBOB might impact production of higher valued products raising the opportunity costs, this is not likely for the other blend stocks. Consequently any constraints imposed on blending with these other components by limiting their availability to CARBOB were viewed as unnecessary.

8.3 CARBOB/ALKYLATE RATIO CLASSES

The predictive model was used in conjunction with estimated blend stock qualities for each region of the world to estimate how much CARBOB could be produced from each barrel of alkylate. Air toxics as well as criteria pollutants must be controlled and were considered in estimating blend opportunities. These ratios are viewed as reasonable representations of how blending could occur in a real world situation and we are confident that the ratios do not over-estimate the technical capability to blend CARBOB.

The CARBOB/Alkylate ratios do not reflect the result of optimized refinery models. Inasmuch as for most regions there are many refineries operating that can provide CARBOB components, it is believed that optimizing the CARBOB blending would tend to over-estimate CARBOB producibility in a way for which there would be no ready calibration or correction. Consequently we believe that optimized CARBOB blending using the blend stock qualities we adopted would result in higher ratios than we are using in this work.

Typical blend stock qualities vary depending on the level of sophistication in a region and the types of crude oils processed. Blend stock qualities were estimated based on Purvin & Gertz experience in other refining assignments and were not generated from refinery models or statistical sources for this assignment.

CARBOB/Alkylate ratios vary widely. Refineries that have only moderately high sulfur FCC gasoline streams with which to blend, conventional, high benzene reformates, and no hydrocrackates or raffinates, typically find CARBOB/Alkylate ratios in the 2.0-2.5 range. At the other end of the spectrum, California refiners who have invested heavily to meet CARB requirements are able to operate with CARBOB/Alkylate ratios in the 6-7 range.

Refiners in distant markets supplying only a small fraction of their gasoline as CARBOB face fewer problems than California refiners who have to produce most or all their gasoline to CARB specifications. Such refiners are able to pick and choose the best blend stocks and divert less attractive materials to other markets for which they are still well suited. Nevertheless, these refiners are unlikely to exceed the CARBOB/Alkylate ratios achieved by California refiners because of the very heavy investments California refiners have made to overcome the obstacles posed by CARB specifications.

In principle CARBOB could be manufactured relying entirely on hydroprocessing including hydrocracking, reforming and hydrotreating. Such an approach would not utilize FCC or alkylation technology and therefore would not use alkylate. The ARCO Cherry Point refinery operates in that manner and is expected to be able to make useful blend stocks at a minimum. Such refineries have the advantage of very low sulfur and zero olefins in all their blend stocks. On the other hand, unless special steps are taken to minimize aromatics and benzene, levels of these materials tend to be very high with this configuration. Outside the U.S. and parts of Western Europe, world benzene controls do not approach the stringency required for CARB gasoline if they exist at all. That factor combined with the dearth of many examples of this type of process orientation indicates that special consideration of these refineries is unwarranted.

The CARBOB/alkylate ratio is sensitive to the selection of oxygenate and varies across cases. Using minimum ethanol without an RVP waiver leads to the lowest ratios since dilution effects are small and a particularly low vapor pressure must be observed on the CARBOB, about 5.8 PSIA. Other oxygenates lead to higher CARBOB/Alkylate ratios.

There is considerable uncertainty in determining the CARBOB/Alkylate ratio to a high degree of accuracy. The ratio is highly dependent on details of stream compositions that are not known for individual refineries and on the level of sophistication with the predictive model that the refiner can achieve. To respond to this difficulty and to avoid over-optimizing the problem, refiners and cases were assigned to CARBOB/Alkylate ratio classes. Classes used are shown in Table 8.3-1.

TABLE 8.3-1
CARBOB/ALKYLATE RATIOS

Low	2.5
Moderate	3.5
High	5.5

Each region in each case was assigned to one of these three ratio classes. Using these class values and the estimate of the volume of alkylate available from each region, the available volume of CARBOB was determined.

8.4 CARBOB/ALKYLATE RATIOS

Each region and case was assigned to one of the CARBOB/Alkylate ratio classes. These assignments were made in consideration of the blend stocks available and the requirements of the case. Table 8.4-1 shows the assignments that were made.

TABLE 8.4-1
CARBOB/ALKYLATE RATIO CLASS ASSIGNMENTS

	Ethanol No Waiver	Ethanol Waiver	TBA	ETBE	Mixed Oxygenates	No Oxygenate
Pacific North West	Low	Low	Medium	Medium	Medium	Low
U.S. Gulf Coast	Low	Low	High	High	High	Low
Caribbean	Low	Low	Low	Low	Low	Low
Europe	Low	Low	High	High	High	Low
Latin America	Low	Low	Low	Low	Low	Low
Middle East	Low	Low	Low	Low	Low	Low
Far East	Low	Low	Low	Low	Low	Low

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Four regions, the Caribbean, Latin America, Middle East and Far East, stood out as having relatively poor control of blend stock qualities. The Hess refinery in the Caribbean is the sole producer and even though much of the refinery's production is oriented toward the U.S. East Coast market, overall sophistication did not seem to support assignment to either the medium or high classes. Latin American and Middle Eastern refineries generally produce only into markets with loose product specifications. The Far East includes Japanese refineries that produce to stringent specifications but those refineries were not the ones considered most likely to produce CARBOB, mostly for logistical reasons. The Chinese market does not have stringent controls and still consumes leaded gasoline. Chinese refiners are the largest group of Far Eastern refiners thought to have reasonable prospects of manufacturing some CARBOB.

The Gulf Coast and Europe are thought to have the best prospects for having high CARBOB/Alkylate ratios. Both regions have very large refining systems and the refineries have a high level of technical sophistication. The European refiners will be entering an era of much lower benzene specifications and the Gulf Coast refiners already are there. Both regions are being called on to produce some gasoline to stringent environmental specifications which are becoming more stringent.

The introduction of more stringent gasoline specifications in Europe and the U.S. could have an unfavorable or favorable impact on CARBOB availability. Refiners in those markets will have to meet new, more stringent specifications which, apart from any capital improvements, diminishes the availability of high quality blendstocks for CARBOB. On the other hand, these refiners as a group generally will respond with expansions or other improvements that increase the pool of high quality materials. The net of these changes is reflected in the information in this section. There is irreducible uncertainty associated with future availability as the actions of the refiners cannot be completely foreseen.

The Pacific North West is a special case. It was assigned to the medium class in part because of its proximity to California and the perceived opportunities for multi-refinery optimization with California. The terms under which Shell is selling the refinery are not known and may negatively influence availability in the future.

The most challenging cases are both ethanol cases and the no oxygenate case. The ethanol case with no RVP waiver requires substantially more stringent RVP blending than all other cases. While it was assumed that adequate debutanization exists, the added difficulty of this case would be expected to be reflected in some reduced ability to manufacture CARBOB. The ethanol waiver case runs into difficulty due to the high oxygen content. The no oxygenates case is more difficult principally because the octane requirements of the case are appreciably higher. In all the oxygenate cases, CARBOB could be blended well below 87 octane due to the octane available from the oxygenates to be added in California. The no oxygenate case required 87 octane of the CARBOB limiting ability to utilize low octane stocks. Furthermore, there is no dilution effect available from the oxygenates in this case. Our review indicated that these factors would not be enough to warrant lower class assignments but as will be discussed in Section 9, they do result in higher costs.

8.5 CARBOB SUPPLIES

CARBOB supplies available from each region in each case were determined by multiplying the alkylate available for CARBOB by the class ratio for that case and region. Table 8.5-1 shows the CARBOB availability for each region for the California only MTBE ban.

TABLE 8.5-1
CARBOB AVAILABILITY
CALIFORNIA ONLY MTBE BAN
(Barrels per Day)

	Ethanol No Waiver	Ethanol Waiver	TBA	ETBE	Mixed Oxygenates	No Oxygenates
Pacific North West	10,000	10,000	14,000	14,000	14,000	10,000
U.S. Gulf Coast	214,000	214,000	470,000	470,000	470,000	214,000
Caribbean	26,000	26,000	26,000	26,000	26,000	26,000
Europe	67,000	67,000	148,000	148,000	148,000	67,000
Latin America	63,000	63,000	63,000	63,000	63,000	63,000
Middle East	21,000	21,000	21,000	21,000	21,000	21,000
Far East	34,000	34,000	34,000	34,000	34,000	34,000

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Table 8.5-2 shows the CARBOB availability for each region for the U.S. wide MTBE ban. The differences among these tables are limited to the USGC region.

TABLE 8.5-2
CARBOB AVAILABILITY
US WIDE MTBE BAN
(Barrels per Day)

	Ethanol No Waiver	Ethanol Waiver	TBA	ETBE	Mixed Oxygenates	No Oxygenates
Pacific North West	10,000	10,000	14,000	14,000	14,000	10,000
U.S. Gulf Coast	107,000	107,000	235,000	235,000	235,000	107,000
Caribbean	26,000	26,000	26,000	26,000	26,000	26,000
Europe	67,000	67,000	148,000	148,000	148,000	67,000
Latin America	63,000	63,000	63,000	63,000	63,000	63,000
Middle East	21,000	21,000	21,000	21,000	21,000	21,000
Far East	34,000	34,000	34,000	34,000	34,000	34,000

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9. SUPPLY COST ESTIMATES

Supply costs were estimated based on the cost of gasoline in each region to which were added cost components representing refinery processing costs, cargo consolidation costs, transportation costs and refiner margin. An octane adjustment was needed to account for the benefit or debit available to the refiner of being able to supply gasoline at an octane different than that prevailing the local market. The processing cost and octane adjustment would be affected by the selection of oxygenate. None of the other cost elements is sensitive to the substitute oxygenate selected.

9.1 BASE GASOLINE COST BY REGION

Base gasoline costs for each region were estimated based on market data for the May through August summer season of 1997. Gasoline costs were determined based on spot price quotations for various markets. Spot price quotations are the best measure of arm's length gasoline values in large volume shipments priced at the refinery gate. Spot price quotations are commonly used in refinery economic analysis work. Other measures of gasoline cost such as rack prices or retail prices are considered inferior measures and would require correction to be used to estimate the cost of supplying imported CARBOB to California. Generally prices other than spot prices would result in over-estimation of the cost of supplying CARBOB. Base gasoline costs were directly available from market. Table 9.1-1 shows the base gasoline costs used for each market. For reference, the average summertime 1997 spot price of CARB reformulated gasoline is estimated to have been 63.7 cents per gallon.

TABLE 9.1-1
BASE GASOLINE COSTS BY REGION
(Cents per Gallon)

Pacific North West	60.9
U.S. Gulf Coast	59.6
Caribbean	59.5
Europe	55.3
Latin America	59.1
Middle East	58.9
Far East	60.5

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9.2 PROCESSING COSTS

Processing costs are small when the CARBOB volume is limited. The least expensive increment of CARBOB supply would be that supply that could be provided with minimal interference with normal refinery operations. That increment would be provided mostly by providing special blends of existing refinery gasoline blend stocks rather than by reconfiguring refinery processing operations or selecting superior feed stocks. Some extra debutanization might occur to ensure that CARBOB RVP specifications could be met. As the fraction of a refinery's gasoline production dedicated to CARBOB rises, then more intensive and expensive changes in the operations or hardware configuration of the refinery are needed. A substantial part of the supply curve for CARBOB can be identified without resorting to high cost methods and that part of the supply curve is expected to be adequate to cover any shortfalls that may result from an MTBE ban.

When refineries are producing limited volumes of CARBOB, most processing costs incurred are blending costs. These costs are reflective mostly of the lost opportunity to blend low cost butane with gasoline. The butane blending opportunity is lost due to the lower vapor pressure required to meet CARB specifications. Butane typically carries a cost well below that of gasoline. Typical summertime gasoline RVP specifications allow some butane to be blended with gasoline but CARB specifications call for such a low RVP that essentially no butane can be blended into CARB gasoline or CARBOB. A refiner electing to manufacture to CARBOB specifications rather than to other, higher vapor pressure specifications would lose the opportunity to profit by blending low cost butane as part of higher valued gasoline.

Processing costs were estimated based on the amount of lost opportunity to blend butane and the prevailing costs of butane and gasoline in each market. Costs vary from region to region because some regions have higher gasoline RVP specifications and because butane and gasoline prices are not the same in all world locations.

A provision of 0.5 cents per gallon of CARBOB was made for incidental direct costs such as costs to clear tankage, extra laboratory testing, any extra energy costs that might be related to more severe debutanization and the like. Table 9.2-1 shows the processing costs for each case.

TABLE 9.2-1
PROCESSING COSTS BY REGION
(Cents per Gallon)

	Ethanol	ETBE	TBA	Others
Pacific North West	4.2	2.8	3.3	3.2
U.S. Gulf Coast	2.0	1.0	1.3	1.3
Caribbean	1.9	1.0	1.2	1.1
Europe	2.8	1.8	2.1	2.0
Latin America	1.7	1.0	1.1	1.1
Middle East	2.0	1.0	1.3	1.2
Far East	2.6	1.8	2.0	2.0

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9.3 OCTANE CREDIT/DEBIT

Octane of regular gasoline, suitable for most automobiles, is typically about 87 (R + M)/2 or about 91 RON. Few markets can be found in which many automobiles will accept substantially lower octane. Many countries also have a lower octane grade commonly used in low compression engines, motorcycles and the like. Price quotations are available for the automotive grades in many locations and these formed the basis for our analysis.

CARBOB could be produced to substantially lower octane than prevailing automotive gasoline specifications. Substantial octane is provided by the oxygenates that are added to CARBOB to produced finished CARB gasoline. Table 9.3-1 below shows the octane of CARBOB needed for each case:

TABLE 9.3-1
CARBOB OCTANE
(R+M)/2

Oxygenate	**Oxygenate Octane**	**Oxygenate Blend Fraction**	**CARBOB Octane**
MTBE	110	0.110	84.2
ETOH - No Waiver	115	0.058	85.3
ETOH - Waiver	115	0.100	83.9
TAME	105	0.124	84.5
ETBE	112	0.127	83.4
TBA	100	0.088	85.7
Mixed	106	0.110	84.5
None	--	--	87.0

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Table 9.3-1 shows the octane for each oxygenate. The mixed oxygenate octane used was the average of the octanes of TAME, ETBE and TBA. The oxygenate blend fraction is the fraction of a final CARB gasoline blend that would be each oxygenate to achieve 2.0 per cent oxygen in the gasoline. For example a CARBOB using ethanol would be 5.8% ethanol to achieve 2.0 percent oxygen. However, federal law requires that the ethanol waiver case contain 10% ethanol in the blend. The last column of Table 9.3-1 shows the octane of the CARBOB that would be blended with the oxygenate to achieve a CARB gasoline octane of 87.

Octane is costly to refiners. Converting low octane materials into high octane materials involves expensive processing like catalytic reforming or costly high octane additives like MTBE. Conversely producing a lower octane product represents a real cost savings to the refiner. Octane costs are not linear in all ranges and the cost for octane at very high ranges is higher than the cost at lower octane ranges. For purposes of evaluating octane costs, we have used a figure of 21 cents per octane barrel or 0.5 cents per octane gallon. These numbers are considered to be at the lower end of the octane cost spectrum.

Even if refiners do not alter processing, they can benefit from producing a lower octane product. Higher octane stocks can be diverted to producing more higher valued premium gasoline and less lower valued regular gasoline.

Because CARBOB can be produced at substantially lower octane than prevailing automotive specifications require and because that octane savings can translate either into refinery cost reductions or to more higher valued premium products (apart from CARBOB), it is appropriate to assign an octane credit to the CARBOB. This credit has been calculated as the octane difference between 87 and the octane of the CARBOB multiplied by 0.5 cents per octane gallon. This credit has the effect of reducing the cost of delivering CARBOB to California. If octane becomes more valuable because of an MTBE ban, then a larger credit would be available. In the interest of conservatism, the lower octane value and credit was used.

China was treated as a special case. China uses lower octane gasoline than most other countries and China is a likely Far Eastern supplier of CARBOB. China is the country that historically has been the largest single supplier of foreign gasoline to California prior to the introduction of CARB gasoline. For these reasons, China's cost structure was chosen to represent Asian suppliers. Because China's gasoline octane is low, about 85 (R+M)/2 on an unleaded basis, the octane credit available to Chinese refiners is correspondingly low.

Table 9.3-2 shows the octane credits for each oxygenate case.

TABLE 9.3-2
OCTANE COST
(Cents per Gallon)

	Far East	Other [1]
Ethanol - Waiver	-0.5	-1.6
Ethanol - No Waiver	0.1	-0.9
ETBE	-0.8	-1.8
TBA	0.4	-0.6
Mixed Oxygenate	-0.2	-1.2
No Oxygenate	0.0	0.0

Note: Based on 87 (R+M)/2 gasoline for all regions except Far East.
Far East is based on 85 (R+M)/2.

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9.4 INVENTORY HOLDING COSTS

Refiners in distant location who produced CARBOB will experience an increase in the amount of time which elapses between their completion of the manufacturing and the time the product is received at the consumption point. Similarly, California consumers using CARB gasoline produced in distant locations rather than in California will experience an increase in the amount of time that elapses between the time the gasoline is produced by the refinery and the time that it is available for purchase. Holding inventory for this additional period of time adds to the cost of supplying fuels. The additional inventory holding costs were calculated based on an estimated additional time and an interest rate. Table 9.4-1 shows the additional costs of holding inventory for each region. The number of additional days inventory is held is dependent on shipping time to California. Costs were estimated based on an interest rate of 8% per annum. There has been no assumption about the specific contract terms and whether these costs are part of the invoiced price for fuel delivered by the distant supplier. No capital investment has been included in this analysis to provide for additional tankage for this purpose.

TABLE 9.4-1
INVENTORY HOLDING COSTS BY REGION
(Cents per Gallon)

Pacific North West	0.3
U.S. Gulf Coast	0.4
Caribbean	0.4
Europe	0.6
Latin America	0.4
Middle East	0.4
Far East	1.8

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There has been neither a specific assessment of nor provision for the additional risk associated with holding the inventory. The degree to which existing California gasoline suppliers feel the need or the ability to hedge their inventory exposure is not clear. While any individual transaction may be subject to risk of a price fall during delivery, over time price increases and decreases tend to cancel out and the cost associated with the additional risk of holding the inventory, as distinct from the cost of capital, is thought to be small relative to the overall costs of an MTBE ban.

9.5 TRANSPORTATION COSTS

Transportation costs have been defined to include the cost of marine transportation as well as the cost of third party terminaling at the point of destination.

“Worldscale” refers to the New Worldwide Tanker Nominal Freight Scale as published annually by the Worldscale Associations of London and New York. The Worldscale schedule provides standardized shipping costs between world petroleum ports and includes consideration of shipping time, typical carriage terms, relevant port and canal fees and the like. Worldscale is widely used to estimate consistent shipping costs for diverse voyages.

Typically, large tankers with relatively low per unit costs charge a fraction of the standard Worldscale rates while small tankers with high costs charge a multiple of standard Worldscale rates. Similarly “clean” vessels suitable for gasoline or diesel fuel charge a higher rate than “dirty” vessels which have contained crude oil or fuel oil. Quotations for the typical tanker charges, relative to Worldscale, are found in many shipping and petroleum industry publications.

Gasoline typically would not be carried internationally in tankers larger than the LR-1 class. LR-1 class tankers are 45,000-80,000 deadweight tonnes which translates into cargo capacity around 15 to 27 million gallons. Though gasoline might also be carried in smaller MR class tankers, we selected LR-1 class tankers for this analysis since the tanker size is a reasonable maximum resulting in the lowest reasonable shipping cost.

Marine transportation costs have been estimated on an arm's length basis. While many oil companies use their own ships, their incurred costs are considered irrelevant to the issue at hand and many prospective suppliers do not have ships available to transport CARBOB to California. Shippings costs were estimated based on Worldscale rates with a market factor of 1.5 applied to account for clean LR-1 sized vessels. This market factor is consistent with market conditions in summer 1997 and is not unusual for clean LR-1 vessels. Worldscale rates, quoted in US dollars per tonne were converted to dollars per gallon based on 353 gallons per tonne.

Worldscale quotations are not useful for voyages from the Pacific North West or USGC to California because of the federal requirement to use Jones Act tankers on such routes. Jones Act tankers must be American flagged and also have been built in U.S. shipyards. Jones Act tankers typically carry much higher costs than international flag carriers. Costs to use Jones Act tankers were estimated based directly on opinions of industry participants. For purposes of this assessment, it has been assumed that adequate Jones Act tonnage could be accessed without adding to costs and costs above the minimum level quoted for Jones Act movements have been used to account for market changes attributable to the increase in movements that might occur in the event of an MTBE ban.

There is some risk that delivering large volumes of CARBOB, alkylate or other products to California and that shipping large volumes of non-CARB gasoline or intermediates away from California might disrupt typically observed ship availabilities or costs. Since such trade would be a very small fraction of international clean products movements, such risk for international origins or destinations is considered small. Domestic shipments would need to be moved using Jones Act carriers, the supply of which is much smaller. Since domestic sources of alkylate or CARBOB might be quite important, a shortage of Jones Act carriers has the potential to shift supply curves.

In the long term, it would be possible, if appropriate contracts for use were in place, to build new Jones Act carriers. New carriers are quite unlikely to be built unless the need for them were expected to be sustained long enough to amortize tanker costs. New tankers meeting new design criteria might logically carry higher costs than older tankers but if such tankers could be designed and dedicated full time to carrying CARBOB or alkylate on domestic routes, the costs could be optimized. Furthermore, the possibility of backhaul cargoes which might develop would further improve cargo-carrying utilization and reduce costs further.

There is a reasonable possibility that if there were long term demand for transportation from the U.S. Gulf Coast to California that pipeline transportation systems might supplant marine shipments for some or most of the business. A project which is under construction but not yet completed is expected to link the Gulf Coast refineries directly to El Paso and allow gasoline from the U.S. Gulf Coast to be shipped as far as Phoenix. If there were adequate shipper interest in doing so, it is possible that the existing pipeline system connecting Los Angeles to Phoenix and El Paso to Phoenix could be expanded and/or reconfigured to allow some volumes of U.S. Gulf Coast products to penetrate California markets. Other pipeline systems in other services that are or could become underutilized might also be used. While evaluation of how speculative pipeline reconfigurations or new construction might contribute to transporting CARBOB or alkylate to California is beyond the scope of this report, in the long term the possibility that entrepreneurs would make use of such systems to serve any reliable, long term need that develops cannot be dismissed.

In the intermediate term, there would not be adequate time to build new tankers or reconfigure pipelines and a Jones Act carrier shortfall could influence CARBOB or alkylate supply patterns. In the event of a shortage of carriers, less efficient and more costly foreign sources might be preferred to potentially less costly domestic products. In principle if Jones Act carriers were simply unavailable product shipments from the U.S. Gulf Coast simply could not be increased regardless of cost or price considerations.

The availability of Jones Act carriers and its potential impact on supplies from the U.S. Gulf Coast or Pacific North West is more fully discussed in the Marine Infrastructure report.

There are miscellaneous charges that must be paid to port and government bodies apart from those covered by Worldscale. These include federal and state oil spill taxes or fees, wharfage, customs duties, other customs charges, and the like. Customs duties are required only on imports from foreign points of origin and not for shipments from either the Pacific North West or the USGC. These have been included for Caribbean points of origin even though the most likely origin of such shipments is the U.S. Virgin Islands since duties might not have been paid on the foreign crude oil used to manufacture products in St. Croix.

On arrival in California, waterborne CARBOB cargoes would require terminaling and blending with the oxygenate. If ethanol is the oxygenate chosen, then the blending would occur as the trucks is loaded to transport the CARB gasoline to the service stations. Otherwise, the blending would occur at or near the marine offloading port.

Marine cargoes of CARBOB most likely would not be handled by refineries but rather would be diverted to marine terminals. While refineries can handle small volumes of inbound blend stocks or even finished products, their tankage and logistics systems are oriented toward inbound crude oil movements and outbound product movements. Furthermore, there is no reason CARBOB would have to be handled at refineries since marine terminals could perform all necessary blending.

A provision of 0.75 cents per gallon was added to provide for average costs for handling and blending at marine terminals in California. This cost level is considered a reasonable average for high volume throughput through existing terminals. Terminaling costs are addressed more completely in the Adequacy of Marine Infrastructure study.

Table 9.5-1 shows the buildup of transportation costs.

TABLE 9.5-1
TRANSPORTATION COSTS BY REGION
(Cents per Gallon, Except as Noted)

Origin	WS100, ($/MT)	Transport	Misc.	Terminalling	Total
Pacific North West	----	5.1	0.5	0.8	6.4
U.S. Gulf Coast	----	8.0	0.5	0.8	9.3
Caribbean	7.7	3.9	1.8	0.8	6.4
Europe	13.6	6.4	1.8	0.8	8.9
Latin America	7.7	3.9	1.8	0.8	6.4
Middle East	19.0	8.1	1.8	0.8	10.6
Far East	10.0	4.2	1.8	0.8	6.8

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9.6 REFINER MARGINS

Refiners outside California will not undertake the expense and nuisance of producing CARBOB unless there is the promise of reasonable profit from doing so. Covering direct costs is an inadequate incentive since there are risks to the refiner and he may incur indirect and opportunity costs which have not been assessed elsewhere in this cost buildup. A provision of 2 cents per gallon has been assigned to all cases to provide for indirect and opportunity costs, other small costs not assessed elsewhere and for refiner margin or profit from producing CARBOB in distant locations.

9.7 TOTAL CARBOB COST

Tables have been prepared showing the total costs of providing CARBOB from outside California. Tables 9.7-1 through 9.7-6 show the costs for each oxygenate case. None of these costs are considered sensitive to whether the MTBE ban is California only or nationwide though the volumes that can be accessed from the USGC do vary depending on this factor as explained in Section 8.

9.8 SUPPLY CURVES

Combining the CARBOB costs from each region as shown in Section 9.7 with the volumes of CARBOB from each region developed in Section 8 results in the supply curve or supply function for CARBOB from external sources. The CARBOB supply curves resulting from the California only MTBE ban are shown in Table 9.8-1. The CARBOB supply curves for the U.S. wide MTBE ban are shown in Table 9.8-2.

9.9 HOBC COSTS

Based on a review of CARBOB blending as well as refiner discussions, the only high octane blending component (HOBC) likely to be relevant to the market other than oxygenates which are being addressed by ESAI, is alkylate. Alkylate is the most important single component for manufacturing CARBOB and ability to purchase additional alkylate could be important to California refiners seeking to manufacture CARB gasoline within the state in lieu of importing CARBOB from distant regions.

Alkylate supply is limited and can be used either to manufacture CARBOB in distant locations or for direct movements to California. Each barrel of alkylate may go to either of these two alternatives but for any given increment of alkylate, the choices are mutually exclusive. Importing alkylate diminishes the availability of imported CARBOB.

There is no regular published source of alkylate pricing relied upon by industry participants for actual transactions. Alkylate is sold on the basis of a premium to gasoline. The typical premium is eight to ten cents per gallon over regular unleaded gasoline though higher figures are quoted from time to time. This premium includes all processing costs as well as octane credits or debits and refiner margin. For purposes of this study, we have adopted a premium of twelve cents per gallon because we believe that market conditions may tighten in the event of an MTBE ban.

Alkylate must be shipped and handled in a manner very similar to gasoline. We believe that alkylate is more likely to be delivered directly to refineries for blending there rather than through marine terminals. Therefore, the terminaling charge has been omitted from the cost of delivering alkylate. All other transportation costs are the same as those for CARBOB.

Table 9.9-1 shows the buildup of alkylate cost from each region of the world.

9.10 HOBC SUPPLY CURVE

Combining the alkylate availability shown in Section 8 with the alkylate supply costs shown in Table 9.9-1 results in the alkylate supply curves. The supply curves for alkylate are shown for the California only MTBE ban and the U.S. wide MTBE ban on Table 9.10-1.

TABLE 9.10-1
EXTERNAL ALKYLATE SUPPLIES

		California Only MTBE Ban Volumes, B/D		Nationwide MTBE Ban Volumes, B/D	
Region	Cost ¢/Gal	Region	Cumulative	Region	Cumulative
Europe	77.0	27,000	27,000	27,000	27,000
Caribbean	78.4	11,000	38,000	11,000	38,000
Latin America	78.1	25,000	63,000	25,000	63,000
Pacific North West	79.7	4,000	67,000	4,000	67,000
Far East	81.4	14,000	81,000	14,000	81,000
U.S. Gulf Coast	81.5	86,000	167,000	43,000	124,000
Middle East	82.1	8,000	175,000	8,000	132,000

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TABLE 9.7-1
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(ETHANOL)

(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	4.2	2.0	1.9	2.8	1.7	2.0	2.6
Octane Credit	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	0.1
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	72.9	72.5	69.3	68.7	68.8	73.0	73.7

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TABLE 9.7-2
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(ETHANOL WAIVER)
(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	3.2	1.3	1.1	2.0	1.1	1.2	2.0
Octane Credit	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-0.5
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	71.2	71.0	67.8	67.2	67.4	71.5	72.5

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TABLE 9.7-3
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(ETBE)
(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	2.8	1.0	1.0	1.8	1.0	1.0	1.8
Octane Credit	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-0.8
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	70.6	70.6	67.4	66.8	67.1	71.1	72.0

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TABLE 9.7-4
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(TBA)
(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	3.3	1.3	1.2	2.1	1.1	1.3	2.0
Octane Credit	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	0.4
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	72.3	72.0	68.9	68.2	68.4	72.6	73.5

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TABLE 9.7-5
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(MIXED OXYGENATE)

(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	3.2	1.3	1.1	2.0	1.1	1.2	2.0
Octane Credit	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-0.2
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	71.6	71.3	68.2	67.5	67.8	71.9	72.8

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TABLE 9.7-6
CARBOB COST BY REGION -- AVERAGE SUMMER 1997(NO OXYGENATE)
(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Processing Cost	3.2	1.3	1.1	2.0	1.1	1.2	2.0
Octane Credit	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inventory Holding Costs	0.3	0.4	0.4	0.6	0.4	0.4	1.8
Transportation Cost	6.4	9.3	6.4	8.9	6.4	10.6	6.8
Refiner Margin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total CIF Cost	72.8	72.6	69.4	68.8	69.0	73.1	73.0

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TABLE 9.8-1
SUPPLY CURVE
EXTERNAL CARBOB SUPPLIES - CALIFORNIA ONLY MTBE BAN

		Ethanol (No Waiver)	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.7	67,000	67,000
Latin America	68.8	63,000	130,000
Caribbean	69.3	26,000	156,000
U.S. Gulf Coast	72.5	214,000	370,000
Pacific North West	72.9	10,000	380,000
Middle East	73.0	21,000	401,000
Far East	73.7	34,000	435,000

		Ethanol (Waiver)	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.2	67,000	67,000
Latin America	67.4	63,000	130,000
Caribbean	67.8	26,000	156,000
U.S. Gulf Coast	71.0	214,000	370,000
Pacific North West	71.2	10,000	380,000
Middle East	71.5	21,000	401,000
Far East	72.5	34,000	435,000

		Mixed Oxygenates	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.5	148,000	148,000
Latin America	67.8	63,000	211,000
Caribbean	68.2	26,000	237,000
U.S. Gulf Coast	71.3	470,000	707,000
Pacific North West	71.6	14,000	721,000
Middle East	71.9	21,000	742,000
Far East	72.8	34,000	776,000

		TBA	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.2	148,000	148,000
Latin America	68.4	63,000	211,000
Caribbean	68.9	26,000	237,000
U.S. Gulf Coast	72.0	470,000	707,000
Pacific North West	72.3	14,000	721,000
Middle East	72.6	21,000	742,000
Far East	73.5	34,000	776,000

		ETBE	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	66.8	148,000	148,000
Latin America	67.1	63,000	211,000
Caribbean	67.4	26,000	237,000
U.S. Gulf Coast	70.6	470,000	707,000
Pacific North West	70.6	14,000	721,000
Middle East	71.1	21,000	742,000
Far East	72.0	34,000	776,000

		No Oxygenates	
	Cost	Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.8	67,000	67,000
Latin America	69.0	63,000	130,000
Caribbean	69.4	26,000	156,000
U.S. Gulf Coast	72.6	214,000	370,000
Pacific North West	72.8	10,000	380,000
Far East	73.0	34,000	414,000
Middle East	73.1	21,000	435,000

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TABLE 9.8-2
SUPPLY CURVE
EXTERNAL CARBOB SUPPLIES - US WIDE MTBE BAN

	Cost	Ethanol (No Waiver) Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.7	67,000	67,000
Latin America	68.8	63,000	130,000
Caribbean	69.3	26,000	156,000
U.S. Gulf Coast	72.5	107,000	263,000
Pacific North West	72.9	10,000	273,000
Middle East	73.0	21,000	294,000
Far East	73.7	34,000	328,000

	Cost	Ethanol (Waiver) Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.2	67,000	67,000
Latin America	67.4	63,000	130,000
Caribbean	67.8	26,000	156,000
Pacific North West	71.0	10,000	166,000
U.S. Gulf Coast	71.2	107,000	273,000
Middle East	71.5	21,000	294,000
Far East	72.5	34,000	328,000

	Cost	Mixed Oxygenates Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	67.5	148,000	148,000
Latin America	67.8	63,000	211,000
Caribbean	68.2	26,000	237,000
Pacific North West	71.3	14,000	251,000
U.S. Gulf Coast	71.6	235,000	486,000
Middle East	71.9	21,000	507,000
Far East	72.8	34,000	541,000

	Cost	TBA Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.2	148,000	148,000
Latin America	68.4	63,000	211,000
Caribbean	68.9	26,000	237,000
U.S. Gulf Coast	72.0	235,000	472,000
Pacific North West	72.3	14,000	486,000
Middle East	72.6	21,000	507,000
Far East	73.5	34,000	541,000

	Cost	ETBE Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	66.8	148,000	148,000
Latin America	67.1	63,000	211,000
Caribbean	67.4	26,000	237,000
Pacific North West	70.6	14,000	251,000
U.S. Gulf Coast	70.6	235,000	486,000
Middle East	71.1	21,000	507,000
Far East	72.0	34,000	541,000

	Cost	No Oxygenates Volumes, B/D	
Region	¢/Gal	Region	Cumulative
Europe	68.8	67,000	67,000
Latin America	69.0	63,000	130,000
Caribbean	69.4	26,000	156,000
Far East	72.6	34,000	190,000
Pacific North West	72.8	10,000	200,000
Middle East	73.0	21,000	221,000
U.S. Gulf Coast	73.1	107,000	328,000

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TABLE 9.9-1
ALKYLATE SUPPLY COST
(Cents per Gallon)

	PNW	USGC	Caribbean	Europe	Latin America	Middle East	Far East
Base Gasoline Price	60.9	59.6	59.5	55.3	59.1	58.9	60.5
Alkylate Premium	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Inventory Holding Costs	0.3	0.5	0.4	0.8	0.5	0.5	2.1
Transportation Cost	6.5	9.4	6.5	9.0	6.5	10.7	6.8
Total CIF Cost	79.7	81.5	78.4	77.0	78.1	82.1	81.4

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